

Product ID: HamRadioExtra

Ham Radio Extra Class

SECRETS

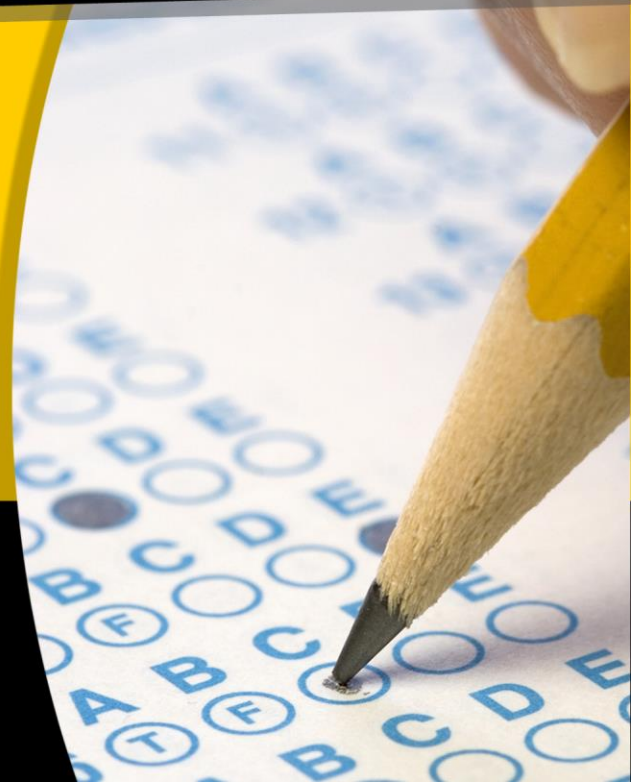
Study Guide

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Ham Radio Practice Questions and
Test Review for the Ham Radio
Extra Class Exam

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Ham Radio Extra Class

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Study Guide
Your Key to Exam Success

Ham Radio Practice Questions and
Test Review for the Ham Radio
Extra Class Exam

Dear Future Exam Success Story:

First of all, **THANK YOU** for purchasing Mometrix study materials!

Second, congratulations! You are one of the few determined test-takers who are committed to doing whatever it takes to excel on your exam. **You have come to the right place.** We developed these study materials with one goal in mind: to deliver you the information you need in a format that's concise and easy to use.

In addition to optimizing your guide for the content of the test, we've outlined our recommended steps for breaking down the preparation process into small, attainable goals so you can make sure you stay on track.

We've also analyzed the entire test-taking process, identifying the most common pitfalls and showing how you can overcome them and be ready for any curveball the test throws you.

Standardized testing is one of the biggest obstacles on your road to success, which only increases the importance of doing well in the high-pressure, high-stakes environment of test day. Your results on this test could have a significant impact on your future, and this guide provides the information and practical advice to help you achieve your full potential on test day.

Your success is our success

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Thanks again for your business and we wish you continued success!

Sincerely,
The Mometrix Test Preparation Team

Need more help? Check out our flashcards at:
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Introduction

The FCC (Federal Communications Commission) has **three levels of licensure**: Technician class, General class, and Extra class. Each class provides further permissions. The Extra class allows for the greatest freedom of amateur radio use.

To aid in the process of studying, the FCC releases the full question pool for the exam. The question pool for the Extra class exam is made up of **50 topics**. Each test will contain one question from each topic. The question pool contains enough questions to provide for at least 10 unique tests.

Because this guide contains the full question pool and 10 practice tests, it is possible to familiarize yourself with the questions to a point where you can pass the test on rote memory alone. However, to do so would be to miss out on a great opportunity to discover what knowledge gaps you have in the field of amateur radio and address them. We recommend that you **study for memory and comprehension simultaneously**. One possible strategy is outlined below:

1. Read through the question bank once to understand the full scope of the topics.
2. Address any obvious knowledge gaps with supplemental research.
3. Take a practice test and score yourself.
4. Examine each question you answered incorrectly and research its topic until you feel confident with that content.
5. Reread the question bank.
6. Repeat steps 3-5 until you comprehend each topic and its questions.

Of course, you should optimize any study plan for your individual strengths. No matter what study plan you follow, if you study diligently, you can be prepared and confident on your test day.

Extra Class Question Pool

E1 – Commission's Rules

E1A – Operating Standards: frequency privileges; emission standards; automatic message forwarding; frequency sharing; stations aboard ships or aircraft

When using a transceiver that displays the carrier frequency of phone signals, which of the following displayed frequencies represents the highest frequency at which a properly adjusted USB emission will be totally within the band?

- A. The exact upper band edge
- B. 300 Hz below the upper band edge
- C. 1 kHz below the upper band edge
- D. 3 kHz below the upper band edge

E1A01 Answer: D. The highest frequency at which a properly adjusted USB emission will be totally within the band is 3 kHz below the upper band edge. [97.301, 97.305]

When using a transceiver that displays the carrier frequency of phone signals, which of the following displayed frequencies represents the lowest frequency at which a properly adjusted LSB emission will be totally within the band?

- A. The exact lower band edge
- B. 300 Hz above the lower band edge
- C. 1 kHz above the lower band edge
- D. 3 kHz above the lower band edge

E1A02 Answer: D. The lowest frequency at which a properly adjusted LSB emission will be totally within the band is 3 kHz above the lower band edge. [97.301, 97.305]

With your transceiver displaying the carrier frequency of phone signals, you hear a station calling CQ on 14.349 MHz USB. Is it legal to return the call using upper sideband on the same frequency?

- A. Yes, because you were not the station calling CQ
- B. Yes, because the displayed frequency is within the 20 meter band
- C. No, the sideband will extend beyond the band edge
- D. No, U.S. stations are not permitted to use phone emissions above 14.340 MHz

E1A03 Answer: C. It is not legal respond using USB on 14.349 MHz because the sideband will extend beyond the band edge. [97.301, 97.305]

With your transceiver displaying the carrier frequency of phone signals, you hear a DX station calling CQ on 3.601 MHz LSB. Is it legal to return the call using lower sideband on the same frequency?

- A. Yes, because the DX station initiated the contact
- B. Yes, because the displayed frequency is within the 75 meter phone band segment
- C. No, the sideband will extend beyond the edge of the phone band segment
- D. No, U.S. stations are not permitted to use phone emissions below 3.610 MHz

E1A04 Answer: C. It is not legal to respond using LSB on 3.601 MHz because the sideband will extend beyond the edge of the phone band segment. [97.301, 97.305]

What is the maximum power output permitted on the 60-meter band?

- A. 50 watts PEP effective radiated power relative to an isotropic radiator
- B. 50 watts PEP effective radiated power relative to a dipole
- C. 100 watts PEP effective radiated power relative to the gain of a half-wave dipole
- D. 100 watts PEP effective radiated power relative to an isotropic radiator

E1A05 Answer: C. The maximum power output permitted on the 60-meter band is 100 W PEP relative to a half-wave dipole. Before March 3, 2012, the maximum was 50 W. [97.313]

Where must the carrier frequency of a CW signal be set to comply with FCC rules for 60-meter operation?

- A. At the lowest frequency of the channel
- B. At the center frequency of the channel
- C. At the highest frequency of the channel
- D. On any frequency where the signal's sidebands are within the channel

E1A06 Answer: B. The carrier frequency of a CW signal must be set at the center frequency of the channel to comply with FCC rules. [97.15]

Which amateur band requires transmission on specific channels rather than on a range of frequencies?

- A. 12 meter band
- B. 17 meter band
- C. 30 meter band
- D. 60 meter band

E1A07 Answer: D. The 60-meter band requires transmission on specific channels rather than on a range of frequencies. [97.303]

If a station in a message forwarding system inadvertently forwards a message that is in violation of FCC rules, who is primarily accountable for the rules violation?

- A. The control operator of the packet bulletin board station
- B. The control operator of the originating station
- C. The control operators of all the stations in the system
- D. The control operators of all the stations in the system not authenticating the source from which they accept communications

E1A08 Answer: B. The control operator of the originating station is primarily accountable if a forwarded message violates FCC rules. [97.219]

What is the first action you should take if your digital message forwarding station inadvertently forwards a communication that violates FCC rules?

- A. Discontinue forwarding the communication as soon as you become aware of it
- B. Notify the originating station that the communication does not comply with FCC rules
- C. Notify the nearest FCC Field Engineer's office
- D. Discontinue forwarding all messages

E1A09 Answer: A. If your digital message forwarding station inadvertently forwards a communication that violates FCC rules, the first thing you should do is stop forwarding the message. [97.219]

If an amateur station is installed aboard a ship or aircraft, what condition must be met before the station is operated?

- A. Its operation must be approved by the master of the ship or the pilot in command of the aircraft
- B. The amateur station operator must agree not to transmit when the main radio of the ship or aircraft is in use
- C. The amateur station must have a power supply that is completely independent of the main ship or aircraft power supply
- D. The amateur operator must have an FCC Marine or Aircraft endorsement on his or her amateur license

E1A10 Answer: A. Amateur stations aboard ships or aircraft do not need special endorsement so long as permission is obtained from the captain or pilot of the craft, and all applicable rules are followed. [97.11]

Which of the following describes authorization or licensing required when operating an amateur station aboard a U.S.-registered vessel in international waters?

- A. Any amateur license with an FCC Marine or Aircraft endorsement
- B. Any FCC-issued amateur license
- C. Only General class or higher amateur licenses
- D. An unrestricted Radiotelephone Operator Permit

E1A11 Answer: B. Any FCC-issued amateur license is suitable for operating an amateur station aboard a U.S.-registered vessel in international waters. [97.5]

With your transceiver displaying the carrier frequency of CW signals, you hear a DX station's CQ on 3.500 MHz. Is it legal to return the call using CW on the same frequency?

- A. Yes, the DX station initiated the contact
- B. Yes, the displayed frequency is within the 80 meter CW band segment
- C. No, one of the sidebands of the CW signal will be out of the band
- D. No, U.S. stations are not permitted to use CW emissions below 3.525 MHz

E1A12 Answer: C. It is not legal to respond using CW on the same frequency because one of the sidebands will be out of the band. [97.301, 97.305]

Who must be in physical control of the station apparatus of an amateur station aboard any vessel or craft that is documented or registered in the United States?

- A. Only a person with an FCC Marine Radio
- B. Any person holding an FCC issued amateur license or who is authorized for alien reciprocal operation
- C. Only a person named in an amateur station license grant
- D. Any person named in an amateur station license grant or a person holding an unrestricted Radiotelephone Operator Permit

E1A13 Answer: B. A person with an FCC issued amateur license or someone who is authorized for alien reciprocal operation must be in physical control of the station apparatus of an amateur station aboard any vessel or craft that is documented or registered in the United States. [97.5]

What is the maximum bandwidth for a data emission on 60 meters?

- A. 60 Hz
- B. 170 Hz
- C. 1.5 kHz
- D. 2.8 kHz

E1A14 Answer: D. The maximum bandwidth for a data emission on 60 meters is 2.8 kHz. [97.303]

E1B – Station restrictions and special operations: restrictions on station location; general operating restrictions, spurious emissions, control operator reimbursement; antenna structure restrictions; RACES operations; national quiet zone

Which of the following constitutes a spurious emission?

- A. An amateur station transmission made at random without the proper call sign identification
- B. A signal transmitted to prevent its detection by any station other than the intended recipient
- C. Any transmitted signal that unintentionally interferes with another licensed radio station
- D. An emission outside its necessary bandwidth that can be reduced or eliminated without affecting the information transmitted

E1B01 Answer: D. A spurious emission is an emission outside its necessary bandwidth that can be reduced or eliminated without affecting the information transmitted. [97.3]

Which of the following factors might cause the physical location of an amateur station apparatus or antenna structure to be restricted?

- A. The location is near an area of political conflict
- B. The location is of geographical or horticultural importance
- C. The location is in an ITU Zone designated for coordination with one or more foreign governments
- D. The location is of environmental importance or significant in American history, architecture, or culture

E1B02 Answer: D. If the location of an amateur station apparatus or antenna structure is of environmental importance or significant in American history, architecture, or culture, it may be restricted. [97.13]

Within what distance must an amateur station protect an FCC monitoring facility from harmful interference?

- A. 1 mile
- B. 3 miles
- C. 10 miles
- D. 30 miles

E1B03 Answer: A. An amateur station located within 1 mile (1600 m) of an FCC monitoring facility must protect it from harmful interference. [97.13]

What must be done before placing an amateur station within an officially designated wilderness area or wildlife preserve, or an area listed in the National Register of Historical Places?

- A. A proposal must be submitted to the National Park Service
- B. A letter of intent must be filed with the National Audubon Society
- C. An Environmental Assessment must be submitted to the FCC
- D. A form FSD-15 must be submitted to the Department of the Interior

E1B04 Answer: C. Before placing an amateur station within an officially designated wilderness area or wildlife preserve, or an area listed in the National Register of Historical Places, an Environmental Assessment must be submitted to the FCC. [97.13, 1.1305-1.1319]

What is the National Radio Quiet Zone?

- A. An area in Puerto Rico surrounding the Arecibo Radio Telescope
- B. An area in New Mexico surrounding the White Sands Test Area
- C. An area surrounding the National Radio Astronomy Observatory
- D. An area in Florida surrounding Cape Canaveral

E1B05 Answer: C. The National Radio Quiet Zone is an area surrounding the National Radio Astronomy Observatory. [97.3]

Which of the following additional rules apply if you are installing an amateur station antenna at a site at or near a public use airport?

- A. You may have to notify the Federal Aviation Administration and register it with the FCC as required by Part 17 of FCC rules
- B. No special rules apply if your antenna structure will be less than 300 feet in height
- C. You must file an Environmental Impact Statement with the EPA before construction begins
- D. You must obtain a construction permit from the airport zoning authority

E1B06 Answer: A. If installing an amateur station antenna at a site at or near a public use airport, you may have to notify the Federal Aviation Administration and register it with the FCC as required by Part 17 of FCC rules. [97.15]

What is the highest modulation index permitted at the highest modulation frequency for angle modulation below 29.0 MHz?

- A. 0.5
- B. 1.0
- C. 2.0
- D. 3.0

E1B07 Answer: B. The highest modulation index permitted at the highest modulation frequency for angle modulation below 29.0 MHz is 1.0. [97.307]

What limitations may the FCC place on an amateur station if its signal causes interference to domestic broadcast reception, assuming that the receivers involved are of good engineering design?

- A. The amateur station must cease operation
- B. The amateur station must cease operation on all frequencies below 30 MHz
- C. The amateur station must cease operation on all frequencies above 30 MHz
- D. The amateur station must avoid transmitting during certain hours on frequencies that cause the interference

E1B08 Answer: D. If an amateur station causes interference to domestic broadcast reception, the FCC may require that the station avoid transmitting during certain hours on frequencies that cause the interference. [97.121]

Which amateur stations may be operated under RACES rules?

- A. Only those club stations licensed to Amateur Extra class operators
- B. Any FCC-licensed amateur station except a Technician class
- C. Any FCC-licensed amateur station certified by the responsible civil defense organization for the area served
- D. Any FCC-licensed amateur station participating in the Military Auxiliary Radio System (MARS)

E1B09 Answer: C. Any FCC-licensed amateur station certified by the responsible civil defense organization for the area served may be operated under RACES rules. [97.407]

What frequencies are authorized to an amateur station operating under RACES rules?

- A. All amateur service frequencies authorized to the control operator
- B. Specific segments in the amateur service MF, HF, VHF and UHF bands
- C. Specific local government channels
- D. Military Auxiliary Radio System (MARS) channels

E1B10 Answer: A. An amateur station operating under RACES rules may use all amateur service frequencies authorized to the control operator. [97.407]

What is the permitted mean power of any spurious emission relative to the mean power of the fundamental emission from a station transmitter or external RF amplifier installed after January 1, 2003 and transmitting on a frequency below 30 MHz?

- A. At least 43 dB below
- B. At least 53 dB below
- C. At least 63 dB below
- D. At least 73 dB below

E1B11 Answer: A. The mean power of any spurious emission from a station transmitter or external RF amplifier installed after January 1, 2003 and transmitting on a frequency below 30 MHz must be at least 43 dB below the mean power of the fundamental emission from the station. [97.307]

E1C – Definitions and restrictions pertaining to local, automatic and remote control operation; control operator responsibilities for remote and automatically controlled stations; IARP and CEPT licenses; third party communications over automatically controlled stations

What is a remotely controlled station?

- A. A station operated away from its regular home location
- B. A station controlled by someone other than the licensee
- C. A station operating under automatic control
- D. A station controlled indirectly through a control link

E1C01 Answer: D. A remotely controlled station is a station controlled indirectly through a control link. [97.3]

What is meant by automatic control of a station?

- A. The use of devices and procedures for control so that the control operator does not have to be present at a control point
- B. A station operating with its output power controlled automatically
- C. Remotely controlling a station's antenna pattern through a directional control link
- D. The use of a control link between a control point and a locally controlled station

E1C02 Answer: A. Automatic control of a station is the use of devices and procedures for control so that the control operator does not have to be present at a control point. [97.3, 97.109]

How do the control operator responsibilities of a station under automatic control differ from one under local control?

- A. Under local control there is no control operator
- B. Under automatic control the control operator is not required to be present at the control point
- C. Under automatic control there is no control operator
- D. Under local control a control operator is not required to be present at a control point

E1C03 Answer: B. The control operator does not have to be present at a station under automatic control. [97.3, 97.109]

What is meant by IARP?

- A. An international amateur radio permit that allows U.S. amateurs to operate in certain countries of the Americas
- B. The internal amateur radio practices policy of the FCC
- C. An indication of increased antenna reflected power
- D. A forecast of intermittent aurora radio propagation

E1C04 Answer: A. IARP is an international amateur radio permit that allows U.S. amateurs to operate in certain countries of the Americas.

When may an automatically controlled station originate third party communications?

- A. Never
- B. Only when transmitting RTTY or data emissions
- C. When agreed upon by the sending or receiving station
- D. When approved by the National Telecommunication and Information Administration

E1C05 Answer: A. An automatically controlled station may never originate third party communications. [97.221(c)(1),97.115(c)]

Which of the following statements concerning remotely controlled amateur stations is true?

- A. Only Extra Class operators may be the control operator of a remote station
- B. A control operator need not be present at the control point
- C. A control operator must be present at the control point
- D. Repeater and auxiliary stations may not be remotely controlled

E1C06 Answer: C. A control operator must be present at the control point of a remotely controlled amateur station. [97.109]

What is meant by local control?

- A. Controlling a station through a local auxiliary link
- B. Automatically manipulating local station controls
- C. Direct manipulation of the transmitter by a control operator
- D. Controlling a repeater using a portable handheld transceiver

E1C07 Answer: C. Local control is direct manipulation of the transmitter by a control operator. [97.3]

What is the maximum permissible duration of a remotely controlled station's transmissions if its control link malfunctions?

- A. 30 seconds
- B. 3 minutes
- C. 5 minutes
- D. 10 minutes

E1C08 Answer: B. The maximum permissible duration of a remotely controlled station's transmissions if its control link malfunctions is 3 minutes. [97.213]

Which of these ranges of frequencies is available for an automatically controlled repeater operating below 30 MHz?

- A. 18.110 MHz – 18.168 MHz
- B. 24.940 MHz – 24.990 MHz
- C. 10.100 MHz – 10.150 MHz
- D. 29.500 MHz – 29.700 MHz

E1C09 Answer: D. An automatically controlled repeater operating below 30 MHz may operate between 29.500 MHz and 29.700 MHz. [97.205]

What types of amateur stations may automatically retransmit the radio signals of other amateur stations?

- A. Only beacon, repeater or space stations
- B. Only auxiliary, repeater or space stations
- C. Only earth stations, repeater stations or model craft
- D. Only auxiliary, beacon or space stations

E1C10 Answer: B. Only auxiliary, repeater or space stations may automatically retransmit the radio signals of other amateur stations. [97.113]

Which of the following operating arrangements allows an FCC-licensed U.S. citizen to operate in many European countries, and alien amateurs from many European countries to operate in the U.S.?

- A. CEPT agreement
- B. IARP agreement
- C. ITU reciprocal license
- D. All of these choices are correct

E1C11 Answer: A. A CEPT agreement allows an FCC-licensed U.S. citizen to operate in many European countries, and alien amateurs from many European countries to operate in the U.S. [97.5]

What types of communications may be transmitted to amateur stations in foreign countries?

- A. Business-related messages for non-profit organizations
- B. Messages intended for connection to users of the maritime satellite service
- C. Communications incidental to the purpose of the amateur service and remarks of a personal nature
- D. All of these choices are correct

E1C12 Answer: C. Communications incidental to the purpose of the amateur service and remarks of a personal nature may be transmitted to amateur stations in foreign countries. [97.117]

Which of the following is required in order to operate in accordance with CEPT rules in foreign countries where permitted?

- A. You must identify in the official language of the country in which you are operating
- B. The U.S. embassy must approve of your operation
- C. You must bring a copy of FCC Public Notice DA 11-221
- D. You must append "/CEPT" to your call sign

E1C13 Answer: C. To operate in accordance with CEPT rules in foreign countries where permitted, you must bring a copy of FCC Public Notice DA 11-221.

E1D – Amateur satellites: definitions and purpose; license requirements for space stations; available frequencies and bands; telecommand and telemetry operations; restrictions, and special provisions; notification requirements

What is the definition of the term telemetry?

- A. One-way transmission of measurements at a distance from the measuring instrument
- B. Two-way radiotelephone transmissions in excess of 1000 feet
- C. Two-way single channel transmissions of data
- D. One-way transmission that initiates, modifies, or terminates the functions of a device at a distance

E1D01 Answer: A. Telemetry is one-way transmission of measurements at a distance from the measuring instrument. [97.3]

What is the amateur satellite service?

- A. A radio navigation service using satellites for the purpose of self training, intercommunication and technical studies carried out by amateurs
- B. A spacecraft launching service for amateur-built satellites
- C. A radio communications service using amateur radio stations on satellites
- D. A radio communications service using stations on Earth satellites for public service broadcast

E1D02 Answer: C. The amateur satellite service is a radio communications service using amateur radio stations on satellites. [97.3]

What is a telecommand station in the amateur satellite service?

- A. An amateur station located on the Earth's surface for communication with other Earth stations by means of Earth satellites
- B. An amateur station that transmits communications to initiate, modify or terminate functions of a space station
- C. An amateur station located more than 50 km above the Earth's surface
- D. An amateur station that transmits telemetry consisting of measurements of upper atmosphere

E1D03 Answer: B. A telecommand station in the amateur satellite service is an amateur station that transmits communications to initiate, modify or terminate functions of a space station. [97.3]

What is an Earth station in the amateur satellite service?

- A. An amateur station within 50 km of the Earth's surface intended for communications with amateur stations by means of objects in space
- B. An amateur station that is not able to communicate using amateur satellites
- C. An amateur station that transmits telemetry consisting of measurement of upper atmosphere
- D. Any amateur station on the surface of the Earth

E1D04 Answer: A. An Earth station in the amateur satellite service is an amateur station within 50 km of the Earth's surface intended for communications with amateur stations by means of objects in space. [97.3]

What class of licensee is authorized to be the control operator of a space station?

- A. All except Technician Class
- B. Only General, Advanced or Amateur Extra Class
- C. Any class with appropriate operator privileges
- D. Only Amateur Extra Class

E1D05 Answer: C. Any license class with appropriate operator privileges is authorized to be the control operator of a space station. [97.207]

Which of the following is a requirement of a space station?

- A. The space station must be capable of terminating transmissions by telecommand when directed by the FCC
- B. The space station must cease all transmissions after 5 years
- C. The space station must be capable of changing its orbit whenever such a change is ordered by NASA
- D. All of these choices are correct

E1D06 Answer: A. A space station must be capable of terminating transmissions by telecommand when directed by the FCC. [97.207]

Which amateur service HF bands have frequencies authorized for space stations?

- A. Only the 40 m, 20 m, 17 m, 15 m, 12 m and 10 m bands
- B. Only the 40 m, 20 m, 17 m, 15 m and 10 m bands
- C. Only the 40 m, 30 m, 20 m, 15 m, 12 m and 10 m bands
- D. All HF bands

E1D07 Answer: A. Only the 40 m, 20 m, 17 m, 15 m, 12 m and 10 m bands have frequencies authorized for space stations. [97.207]

Which VHF amateur service bands have frequencies available for space stations?

- A. 6 meters and 2 meters
- B. 6 meters, 2 meters, and 1.25 meters
- C. 2 meters and 1.25 meters
- D. 2 meters

E1D08 Answer: D. The 2-meter amateur service bands have frequencies available for space stations. [97.207]

Which UHF amateur service bands have frequencies available for a space station?

- A. 70 cm only
- B. 70 cm and 13 cm
- C. 70 cm and 33 cm
- D. 33 cm and 13 cm

E1D09 Answer: B. The 70 cm and 13 cm amateur service bands have frequencies available for space stations. [97.207]

Which amateur stations are eligible to be telecommand stations?

- A. Any amateur station designated by NASA
- B. Any amateur station so designated by the space station licensee, subject to the privileges of the class of operator license held by the control operator
- C. Any amateur station so designated by the ITU
- D. All of these choices are correct

E1D10 Answer: B. Any amateur station so designated by the space station licensee is eligible to be a telecommand station, subject to the privileges of the class of operator license held by the control operator. [97.211]

Which amateur stations are eligible to operate as Earth stations?

- A. Any amateur station whose licensee has filed a pre-space notification with the FCC's International Bureau
- B. Only those of General, Advanced or Amateur Extra Class operators
- C. Only those of Amateur Extra Class operators
- D. Any amateur station, subject to the privileges of the class of operator license held by the control operator

E1D11 Answer: D. Any amateur station is eligible to operate as an Earth station, subject to the privileges of the class of operator license held by the control operator. [97.209]

E1E – Volunteer examiner program: definitions; qualifications; preparation and administration of exams; accreditation; question pools; documentation requirements

What is the minimum number of qualified VEs required to administer an Element 4 amateur operator license examination?

- A. 5
- B. 2
- C. 4
- D. 3

E1E01 Answer: D. The minimum number of qualified VEs required to administer an Element 4 amateur operator license examination is 3. [97.509]

Where are the questions for all written U.S. amateur license examinations listed?

- A. In FCC Part 97
- B. In a question pool maintained by the FCC
- C. In a question pool maintained by all the VECs
- D. In the appropriate FCC Report and Order

E1E02 Answer: C. The questions for all written U.S. amateur license examinations listed are in a question pool maintained by all the VECs. [97.523]

What is a Volunteer Examiner Coordinator?

- A. A person who has volunteered to administer amateur operator license examinations
- B. A person who has volunteered to prepare amateur operator license examinations
- C. An organization that has entered into an agreement with the FCC to coordinate amateur operator license examinations
- D. The person who has entered into an agreement with the FCC to be the VE session manager

E1E03 Answer: C. A Volunteer Examiner Coordinator is an organization that has entered into an agreement with the FCC to coordinate amateur operator license examinations. [97.521]

Which of the following best describes the Volunteer Examiner accreditation process?

- A. Each General, Advanced and Amateur Extra Class operator is automatically accredited as a VE when the license is granted
- B. The amateur operator applying must pass a VE examination administered by the FCC Enforcement Bureau
- C. The prospective VE obtains accreditation from the FCC
- D. The procedure by which a VEC confirms that the VE applicant meets FCC requirements to serve as an examiner

E1E04 Answer: D. The Volunteer Examiner accreditation process is the procedure by which a VEC confirms that the VE applicant meets FCC requirements to serve as an examiner. [97.509, 97.525]

What is the minimum passing score on amateur operator license examinations?

- A. Minimum passing score of 70%
- B. Minimum passing score of 74%
- C. Minimum passing score of 80%
- D. Minimum passing score of 77%

E1E05 Answer: B. The minimum passing score on amateur operator license examinations is 74%. [97.503]

Who is responsible for the proper conduct and necessary supervision during an amateur operator license examination session?

- A. The VEC coordinating the session
- B. The FCC
- C. Each administering VE
- D. The VE session manager

E1E06 Answer: C. Each administering VE is responsible for the proper conduct and necessary supervision during an amateur operator license examination session. [97.509]

What should a VE do if a candidate fails to comply with the examiner's instructions during an amateur operator license examination?

- A. Warn the candidate that continued failure to comply will result in termination of the examination
- B. Immediately terminate the candidate's examination
- C. Allow the candidate to complete the examination, but invalidate the results
- D. Immediately terminate everyone's examination and close the session

E1E07 Answer: B. If a candidate fails to comply with the examiner's instructions during an amateur operator license examination, the VE should immediately terminate the candidate's examination. [97.509]

To which of the following examinees may a VE not administer an examination?

- A. Employees of the VE
- B. Friends of the VE
- C. Relatives of the VE as listed in the FCC rules
- D. All of these choices are correct

E1E08 Answer: C. A VE may not administer an examination to his or her own relatives, as listed in the FCC rules. [97.509]

What may be the penalty for a VE who fraudulently administers or certifies an examination?

- A. Revocation of the VE's amateur station license grant and the suspension of the VE's amateur operator license grant
- B. A fine of up to \$1000 per occurrence
- C. A sentence of up to one year in prison
- D. All of these choices are correct

E1E09 Answer: A. A VE who fraudulently administers or certifies an examination may be subject to revocation of his or her amateur station license grant and suspension of his or her amateur operator license grant. [97.509]

What must the administering VEs do after the administration of a successful examination for an amateur operator license?

- A. They must collect and send the documents to the NCVEC for grading
- B. They must collect and submit the documents to the coordinating VEC for grading
- C. They must submit the application document to the coordinating VEC according to the coordinating VEC instructions
- D. They must collect and send the documents to the FCC according to instructions

E1E10 Answer: C. The administering VEs must submit the application document to the coordinating VEC according to the coordinating VEC's instructions after the administration of a successful examination for an amateur operator license. [97.509]

What must the VE team do if an examinee scores a passing grade on all examination elements needed for an upgrade or new license?

- A. Photocopy all examination documents and forward them to the FCC for processing
- B. Three VEs must certify that the examinee is qualified for the license grant and that they have complied with the administering VE requirements
- C. Issue the examinee the new or upgrade license
- D. All these choices are correct

E1E11 Answer: B. If an examinee scores a passing grade on all examination elements needed for an upgrade or new license, the VE team must certify that the examinee is qualified for the license grant and that they have complied with the administering VE requirements. [97.509]

What must the VE team do with the application form if the examinee does not pass the exam?

- A. Return the application document to the examinee
- B. Maintain the application form with the VEC's records
- C. Send the application form to the FCC and inform the FCC of the grade
- D. Destroy the application form

E1E12 Answer: A. If the examinee does not pass the exam the VE team must return the application document to the examinee. [97.509]

Which of these choices is an acceptable method for monitoring the applicants if a VEC opts to conduct an exam session remotely?

- A. Record the exam session on video tape for later review by the
VE team
- B. Use a real-time video link and the Internet to connect the exam session to the observing VEs
- C. The exam proctor observes the applicants and reports any violations
- D. Have each applicant sign an affidavit stating that all session rules were followed

E1E13 Answer: B. If a VEC opts to conduct an exam session remotely, they should use a real-time video link and the Internet to connect the exam session to the observing VEs. [97.509]

For which types of out-of-pocket expenses do the Part 97 rules state that VEs and VECs may be reimbursed?

- A. Preparing, processing, administering and coordinating an examination for an amateur radio license
- B. Teaching an amateur operator license examination preparation course
- C. No expenses are authorized for reimbursement
- D. Providing amateur operator license examination preparation training materials

E1E14 Answer: A. The Part 97 rules state that VEs and VECs may be reimbursed for preparing, processing, administering and coordinating an examination for an amateur radio license. [97.527]

E1F – Miscellaneous rules: external RF power amplifiers; business communications; compensated communications; spread spectrum; auxiliary stations; reciprocal operating privileges; special temporary authority

On what frequencies are spread spectrum transmissions permitted?

- A. Only on amateur frequencies above 50 MHz
- B. Only on amateur frequencies above 222 MHz
- C. Only on amateur frequencies above 420 MHz
- D. Only on amateur frequencies above 144 MHz

E1F01 Answer: B. spread spectrum transmissions are permitted only on amateur frequencies above 222 MHz. [97.305]

What privileges are authorized in the U.S. to persons holding an amateur service license granted by the Government of Canada?

- A. None, they must obtain a U.S. license
- B. All privileges of the Extra Class license
- C. The operating terms and conditions of the Canadian amateur service license, not to exceed U.S. Extra Class privileges
- D. Full privileges, up to and including those of the Extra Class License, on the 80, 40, 20, 15, and 10 meter bands

E1F02 Answer: C. Persons in the US holding an amateur service license granted by the Government of Canada are granted the operating terms and conditions of the Canadian amateur service license, not to exceed U.S. Extra Class privileges. [97.107]

Under what circumstances may a dealer sell an external RF power amplifier capable of operation below 144 MHz if it has not been granted FCC certification?

- A. It was purchased in used condition from an amateur operator and is sold to another amateur operator for use at that operator's station
- B. The equipment dealer assembled it from a kit
- C. It was imported from a manufacturer in a country that does not require certification of RF power amplifiers
- D. It was imported from a manufacturer in another country and was certificated by that country's government

E1F03 Answer: A. A dealer may sell an external RF power amplifier capable of operation below 144 MHz if it has not been granted FCC certification if it was purchased in used condition from an amateur operator and is sold to another amateur operator for use at that operator's station. [97.315]

Which of the following geographic descriptions approximately describes "Line A"?

- A. A line roughly parallel to and south of the U.S.-Canadian border
- B. A line roughly parallel to and west of the U.S. Atlantic coastline
- C. A line roughly parallel to and north of the U.S.-Mexican border and Gulf coastline
- D. A line roughly parallel to and east of the U.S. Pacific coastline

E1F04 Answer: A. "Line A" is a line roughly parallel to and south of the U.S.-Canadian border. [97.3]

Amateur stations may not transmit in which of the following frequency segments if they are located in the contiguous 48 states and north of Line A?

- A. 440 MHz – 450 MHz
- B. 53 MHz – 54 MHz
- C. 222 MHz – 223 MHz
- D. 420 MHz – 430 MHz

E1F05 Answer: D. Amateur stations may not transmit on frequencies between 222 MHz and 223 MHz if they are located in the contiguous 48 states and north of Line A. [97.303]

Under what circumstances might the FCC issue a Special Temporary Authority (STA) to an amateur station?

- A. To provide for experimental amateur communications
- B. To allow regular operation on Land Mobile channels
- C. To provide additional spectrum for personal use
- D. To provide temporary operation while awaiting normal licensing

E1F06 Answer: A. The FCC might issue a Special Temporary Authority (STA) to an amateur station to provide for experimental amateur communications. [1.931]

When may an amateur station send a message to a business?

- A. When the total money involved does not exceed \$25
- B. When the control operator is employed by the FCC or another government agency
- C. When transmitting international third-party communications
- D. When neither the amateur nor his or her employer has a pecuniary interest in the communications

E1F07 Answer: D. An amateur station may send a message to a business when neither the amateur nor his or her employer has a pecuniary interest in the communications. [97.113]

Which of the following types of amateur station communications are prohibited?

- A. Communications transmitted for hire or material compensation, except as otherwise provided in the rules
- B. Communications that have a political content, except as allowed by the Fairness Doctrine
- C. Communications that have a religious content
- D. Communications in a language other than English

E1F08 Answer: A. Amateur station communications transmitted for hire or material compensation are prohibited, except as otherwise provided in the rules. [97.113]

Which of the following conditions apply when transmitting spread spectrum emission?

- A. A station transmitting SS emission must not cause harmful interference to other stations employing other authorized emissions
- B. The transmitting station must be in an area regulated by the FCC or in a country that permits SS emissions
- C. The transmission must not be used to obscure the meaning of any communication
- D. All of these choices are correct

E1F09 Answer: D. When transmitting spread spectrum emission, the station must not cause harmful interference to other stations employing other authorized emissions, the transmitting station must be in an area regulated by the FCC or in a country that permits SS emissions, and the transmission must not be used to obscure the meaning of any communication. [97.311]

What is the maximum permitted transmitter peak envelope power for an amateur station transmitting spread spectrum communications?

- A. 1 W
- B. 1.5 W
- C. 10 W
- D. 1.5 kW

E1F10 Answer: C. The maximum permitted transmitter peak envelope power for an amateur station transmitting spread spectrum communications is 10 W. [97.313]

Which of the following best describes one of the standards that must be met by an external RF power amplifier if it is to qualify for a grant of FCC certification?

- A. It must produce full legal output when driven by not more than 5 watts of mean RF input power
- B. It must be capable of external RF switching between its input and output networks
- C. It must exhibit a gain of 0 dB or less over its full output range
- D. It must satisfy the FCC's spurious emission standards when operated at the lesser of 1500 watts or its full output power

E1F11 Answer: D. An external RF power amplifier must satisfy the FCC's spurious emission standards when operated at the lesser of 1500 watts or its full output power if it is to qualify for a grant of FCC certification. [97.317]

Who may be the control operator of an auxiliary station?

- A. Any licensed amateur operator
- B. Only Technician, General, Advanced or Amateur Extra Class operators
- C. Only General, Advanced or Amateur Extra Class operators
- D. Only Amateur Extra Class operators

E1F12 Answer: B. Only Technician, General, Advanced or Amateur Extra Class operators may be control operators of auxiliary stations. [97.201]

E2 – Operating Procedures

E2A – Amateur radio in space: amateur satellites; orbital mechanics; frequencies and modes; satellite hardware; satellite operations; experimental telemetry applications

What is the direction of an ascending pass for an amateur satellite?

- A. From west to east
- B. From east to west
- C. From south to north
- D. From north to south

E2A01 Answer: C. An amateur satellite goes from south to north in an ascending pass.

What is the direction of a descending pass for an amateur satellite?

- A. From north to south
- B. From west to east
- C. From east to west
- D. From south to north

E2A02 Answer: A. An amateur satellite goes from north to south in a descending pass.

What is the orbital period of an Earth satellite?

- A. The point of maximum height of a satellite's orbit
- B. The point of minimum height of a satellite's orbit
- C. The time it takes for a satellite to complete one revolution around the Earth
- D. The time it takes for a satellite to travel from perigee to apogee

E2A03 Answer: C. The orbital period of an Earth satellite is the time it takes for a satellite to complete one revolution around the Earth.

What is meant by the term mode as applied to an amateur radio satellite?

- A. The type of signals that can be relayed through the satellite
- B. The satellite's uplink and downlink frequency bands
- C. The satellite's orientation with respect to the Earth
- D. Whether the satellite is in a polar or equatorial orbit

E2A04 Answer: B. The term mode as applied to an amateur radio satellite refers to the satellite's uplink and downlink frequency bands.

What do the letters in a satellite's mode designator specify?

- A. Power limits for uplink and downlink transmissions
- B. The location of the ground control station
- C. The polarization of uplink and downlink signals
- D. The uplink and downlink frequency ranges

E2A05 Answer: D. The letters in a satellite's mode designator specify the uplink and downlink frequency ranges.

On what band would a satellite receive signals if it were operating in mode U/V?

- A. 435 MHz – 438 MHz
- B. 144 MHz – 146 MHz
- C. 50.0 MHz – 50.2 MHz
- D. 29.5 MHz – 29.7 MHz

E2A06 Answer: A. a satellite would receive signals between 435 MHz and 438 MHz if it were operating in mode U/V.

Which of the following types of signals can be relayed through a linear transponder?

- A. FM and CW
- B. SSB and SSTV
- C. PSK and Packet
- D. All of these choices are correct

E2A07 Answer: D. FM, CW, SSB, SSTV, PSK, and Packet signals can all be relayed through a linear transponder.

Why should effective radiated power to a satellite which uses a linear transponder be limited?

- A. To prevent creating errors in the satellite telemetry
- B. To avoid reducing the downlink power to all other users
- C. To prevent the satellite from emitting out-of-band signals
- D. To avoid interfering with terrestrial QSOs

E2A08 Answer: B. Effective radiated power should be limited to a satellite which uses a linear transponder to avoid reducing the downlink power to all other users.

What do the terms L band and S band specify with regard to satellite communications?

- A. The 23 centimeter and 13 centimeter bands
- B. The 2 meter and 70 centimeter bands
- C. FM and Digital Store-and-Forward systems
- D. Which sideband to use

E2A09 Answer: A. The terms L band and S band specify the 23 centimeter and 13 centimeter bands, respectively, with regard to satellite communications.

Why may the received signal from an amateur satellite exhibit a rapidly repeating fading effect?

- A. Because the satellite is spinning
- B. Because of ionospheric absorption
- C. Because of the satellite's low orbital altitude
- D. Because of the Doppler Effect

E2A10 Answer: A. The received signal from an amateur satellite may exhibit a rapidly repeating fading effect because the satellite is spinning.

What type of antenna can be used to minimize the effects of spin modulation and Faraday rotation?

- A. A linearly polarized antenna
- B. A circularly polarized antenna
- C. An isotropic antenna
- D. A log-periodic dipole array

E2A11 Answer: B. A circularly polarized antenna can be used to minimize the effects of spin modulation and Faraday rotation.

What is one way to predict the location of a satellite at a given time?

- A. By means of the Doppler data for the specified satellite
- B. By subtracting the mean anomaly from the orbital inclination
- C. By adding the mean anomaly to the orbital inclination
- D. By calculations using the Keplerian elements for the specified satellite

E2A12 Answer: D. One way to predict the location of a satellite at a given time is by using calculations with the Keplerian elements for the specified satellite.

What type of satellite appears to stay in one position in the sky?

- A. HEO
- B. Geostationary
- C. Geomagnetic
- D. LEO

E2A13 Answer: B. A geostationary satellite appears to stay in one position in the sky.

What technology is used to track, in real time, balloons carrying amateur radio transmitters?

- A. Radar
- B. Bandwidth compressed LORAN
- C. APRS
- D. Doppler shift of beacon signals

E2A14 Answer: C. APRS technology is used to track balloons carrying amateur radio transmitters in real time.

E2B – Television practices: fast scan television standards and techniques; slow scan television standards and techniques

How many times per second is a new frame transmitted in a fast-scan (NTSC) television system?

- A. 30
- B. 60
- C. 90
- D. 120

E2B01 Answer: A. A new frame transmitted 30 times per second in a fast-scan (NTSC) television system.

How many horizontal lines make up a fast-scan (NTSC) television frame?

- A. 30
- B. 60
- C. 525
- D. 1080

E2B02 Answer: C. There are 525 horizontal lines in a fast-scan (NTSC) television frame.

How is an interlaced scanning pattern generated in a fast-scan (NTSC) television system?

- A. By scanning two fields simultaneously
- B. By scanning each field from bottom to top
- C. By scanning lines from left to right in one field and right to left in the next
- D. By scanning odd numbered lines in one field and even numbered lines in the next

E2B03 Answer: D. In a fast-scan (NTSC) television system, an interlaced scanning pattern is generated by scanning odd numbered lines in one field and even numbered lines in the next.

What is blanking in a video signal?

- A. Synchronization of the horizontal and vertical sync pulses
- B. Turning off the scanning beam while it is traveling from right to left or from bottom to top
- C. Turning off the scanning beam at the conclusion of a transmission
- D. Transmitting a black and white test pattern

E2B04 Answer: B. Blanking in a video signal is turning off the scanning beam while it is traveling from right to left or from bottom to top.

Which of the following is an advantage of using vestigial sideband for standard fast-scan TV transmissions?

- A. The vestigial sideband carries the audio information
- B. The vestigial sideband contains chroma information
- C. Vestigial sideband reduces bandwidth while allowing for simple video detector circuitry
- D. Vestigial sideband provides high frequency emphasis to sharpen the picture

E2B05 Answer: C. An advantage of using vestigial sideband for standard fast-scan TV transmissions is reducing bandwidth while allowing for simple video detector circuitry.

What is vestigial sideband modulation?

- A. Amplitude modulation in which one complete sideband and a portion of the other are transmitted
- B. A type of modulation in which one sideband is inverted
- C. Narrow-band FM modulation achieved by filtering one sideband from the audio before frequency modulating the carrier
- D. Spread spectrum modulation achieved by applying FM modulation following single sideband amplitude modulation

E2B06 Answer: A. Vestigial sideband modulation is amplitude modulation in which one complete sideband and a portion of the other are transmitted.

What is the name of the signal component that carries color information in NTSC video?

- A. Luminance
- B. Chroma
- C. Hue
- D. Spectral Intensity

E2B07 Answer: B. The signal component that carries color information in NTSC video is chroma.

Which of the following is a common method of transmitting accompanying audio with amateur fast-scan television?

- A. Frequency-modulated sub-carrier
- B. A separate VHF or UHF audio link
- C. Frequency modulation of the video carrier
- D. All of these choices are correct

E2B08 Answer: D. Frequency-modulated sub-carriers, separate VHF or UHF audio links, and frequency modulation of the video carrier are all common methods of transmitting accompanying audio with amateur fast-scan television.

What hardware, other than a receiver with SSB capability and a suitable computer, is needed to decode SSTV using Digital Radio Mondiale (DRM)?

- A. A special IF converter
- B. A special front end limiter
- C. A special notch filter to remove synchronization pulses
- D. No other hardware is needed

E2B09 Answer: D. The only hardware required to decode SSTV using Digital Radio Mondiale (DRM) is a receiver with SSB capability and a suitable computer.

Which of the following is an acceptable bandwidth for Digital Radio Mondiale (DRM) based voice or SSTV digital transmissions made on the HF amateur bands?

- A. 3 KHz
- B. 10 KHz
- C. 15 KHz
- D. 20 KHz

E2B10 Answer: A. 3 KHz is an acceptable bandwidth for Digital Radio Mondiale (DRM) based voice or SSTV digital transmissions made on the HF amateur bands.

What is the function of the Vertical Interval Signaling (VIS) code sent as part of an SSTV transmission?

- A. To lock the color burst oscillator in color SSTV images
- B. To identify the SSTV mode being used
- C. To provide vertical synchronization
- D. To identify the call sign of the station transmitting

E2B11 Answer: B. The Vertical Interval Signaling (VIS) code is sent as part of an SSTV transmission to identify the SSTV mode being used.

How are analog SSTV images typically transmitted on the HF bands?

- A. Video is converted to equivalent Baudot representation
- B. Video is converted to equivalent ASCII representation
- C. Varying tone frequencies representing the video are transmitted using PSK
- D. Varying tone frequencies representing the video are transmitted using single sideband

E2B12 Answer: D. Analog SSTV images are typically transmitted on the HF bands using single sideband, with varying tone frequencies representing the video.

How many lines are commonly used in each frame of an amateur slow-scan color television picture?

- A. 30 or 60
- B. 60 or 100
- C. 128 or 256
- D. 180 or 360

E2B13 Answer: C. 128 or 256 lines are commonly used in each frame of an amateur slow-scan color television picture.

What aspect of an amateur slow-scan television signal encodes the brightness of the picture?

- A. Tone frequency
- B. Tone amplitude
- C. Sync amplitude
- D. Sync frequency

E2B14 Answer: A. The tone frequency encodes the brightness of the picture in an amateur slow-scan television signal.

What signals SSTV receiving equipment to begin a new picture line?

- A. Specific tone frequencies
- B. Elapsed time
- C. Specific tone amplitudes
- D. A two-tone signal

E2B15 Answer: A. Specific tone frequencies tell SSTV receiving equipment to begin a new picture line.

Which is a video standard used by North American Fast Scan ATV stations?

- A. PAL
- B. DRM
- C. Scottie
- D. NTSC

E2B16 Answer: D. NTSC is a video standard used by North American Fast Scan ATV stations.

What is the approximate bandwidth of a slow-scan TV signal?

- A. 600 Hz
- B. 3 kHz
- C. 2 MHz
- D. 6 MHz

E2B17 Answer: B. The approximate bandwidth of a slow-scan TV signal is 3 kHz.

On which of the following frequencies is one likely to find FM ATV transmissions?

- A. 14.230 MHz
- B. 29.6 MHz
- C. 52.525 MHz
- D. 1255 MHz

E2B18 Answer: D. One is likely to find FM ATV transmissions at 1255 MHz.

What special operating frequency restrictions are imposed on slow scan TV transmissions?

- A. None; they are allowed on all amateur frequencies
- B. They are restricted to 7.245 MHz, 14.245 MHz, 21.345 MHz, and 28.945 MHz
- C. They are restricted to phone band segments and their bandwidth can be no greater than that of a voice signal of the same modulation type
- D. They are not permitted above 54 MHz

E2B19 Answer: C. Slow scan TV transmissions are restricted to phone band segments and their bandwidth can be no greater than that of a voice signal of the same modulation type.

E2C – Operating methods: contest and DX operating; remote operation techniques; Cabrillo format; QSLing; RF network connected systems

Which of the following is true about contest operating?

- A. Operators are permitted to make contacts even if they do not submit a log
- B. Interference to other amateurs is unavoidable and therefore acceptable
- C. It is mandatory to transmit the call sign of the station being worked as part of every transmission to that station
- D. Every contest requires a signal report in the exchange

E2C01 Answer: A. In contest operating, operators are permitted to make contacts even if they do not submit a log.

Which of the following best describes the term self-spotting in regards to HF contest operating?

- A. The generally prohibited practice of posting one's own call sign and frequency on a spotting network
- B. The acceptable practice of manually posting the call signs of stations on a spotting network
- C. A manual technique for rapidly zero beating or tuning to a station's frequency before calling that station
- D. An automatic method for rapidly zero beating or tuning to a station's frequency before calling that station

E2C02 Answer: A. In HF contest operating, self-spotting is the generally prohibited practice of posting one's own call sign and frequency on a spotting network.

From which of the following bands is amateur radio contesting generally excluded?

- A. 30 m
- B. 6 m
- C. 2 m
- D. 33 cm

E2C03 Answer: A. amateur radio contesting is generally excluded from the 30 meter band.

What type of transmission is most often used for a ham radio mesh network?

- A. Spread spectrum in the 2.4 GHz band
- B. Multiple Frequency Shift Keying in the 10 GHz band
- C. Store and forward on the 440 MHz band
- D. Frequency division multiplex in the 24 GHz band

E2C04 Answer: A. Spread spectrum in the 2.4 GHz band is most often used for a ham radio mesh network.

What is the function of a DX QSL Manager?

- A. To allocate frequencies for DXpeditions
- B. To handle the receiving and sending of confirmation cards for a DX station
- C. To run a net to allow many stations to contact a rare DX station
- D. To relay calls to and from a DX station

E2C05 Answer: B. A DX QSL Manager handles the receiving and sending of confirmation cards for a DX station.

During a VHF/UHF contest, in which band segment would you expect to find the highest level of activity?

- A. At the top of each band, usually in a segment reserved for contests
- B. In the middle of each band, usually on the national calling frequency
- C. In the weak signal segment of the band, with most of the activity near the calling frequency
- D. In the middle of the band, usually 25 kHz above the national calling frequency

E2C06 Answer: C. During a VHF/UHF contest, you would expect to find the highest activity in the weak signal segment of the band, with most of the activity near the calling frequency.

What is the Cabrillo format?

- A. A standard for submission of electronic contest logs
- B. A method of exchanging information during a contest QSO
- C. The most common set of contest rules
- D. The rules of order for meetings between contest sponsors

E2C07 Answer: A. The Cabrillo format is a standard for submission of electronic contest logs.

Which of the following contacts may be confirmed through the U.S. QSL bureau system?

- A. Special event contacts between stations in the U.S.
- B. Contacts between a U.S. station and a non-U.S. station
- C. Repeater contacts between U.S. club members
- D. Contacts using tactical call signs

E2C08 Answer: B. Contacts between a U.S. station and a non-U.S. station may be confirmed through the U.S. QSL bureau system.

What type of equipment is commonly used to implement a ham radio mesh network?

- A. A 2 meter VHF transceiver with a 1200 baud modem
- B. An optical cable connection between the USB ports of 2 separate computers
- C. A standard wireless router running custom software
- D. A 440 MHz transceiver with a 9600 baud modem

E2C09 Answer: C. Standard wireless routers running custom software are commonly used to implement ham radio mesh networks.

Why might a DX station state that they are listening on another frequency?

- A. Because the DX station may be transmitting on a frequency that is prohibited to some responding stations
- B. To separate the calling stations from the DX station
- C. To improve operating efficiency by reducing interference
- D. All of these choices are correct

E2C10 Answer: D. A DX station may state that they are listening on another frequency for a number of reasons, including because they may be transmitting on a frequency that is prohibited to some responding stations, to separate the calling stations from the DX station, and to improve operating efficiency by reducing interference.

How should you generally identify your station when attempting to contact a DX station during a contest or in a pileup?

- A. Send your full call sign once or twice
- B. Send only the last two letters of your call sign until you make contact
- C. Send your full call sign and grid square
- D. Send the call sign of the DX station three times, the words "this is", then your call sign three times

E2C11 Answer: A. When attempting to contact a DX station during a contest or in a pileup, you should generally identify your station by sending your full call sign once or twice.

What might help to restore contact when DX signals become too weak to copy across an entire HF band a few hours after sunset?

- A. Switch to a higher frequency HF band
- B. Switch to a lower frequency HF band
- C. Wait 90 minutes or so for the signal degradation to pass
- D. Wait 24 hours before attempting another communication on the band

E2C12 Answer: B. When DX signals become too weak to copy across an entire HF band a few hours after sunset, you should switch to a lower frequency HF band.

What indicator is required to be used by U.S.-licensed operators when operating a station via remote control where the transmitter is located in the U.S.?

- A. / followed by the USPS two letter abbreviation for the state in which the remote station is located
- B. /R# where # is the district of the remote station
- C. The ARRL section of the remote station
- D. No additional indicator is required

E2C13 Answer: D. No additional indicator is required when U.S.-licensed operators operate a station via remote control where the transmitter is located in the U.S.

E2D – Operating methods: VHF and UHF digital modes and procedures; APRS; EME procedures, meteor scatter procedures

Which of the following digital modes is especially designed for use for meteor scatter signals?

- A. WSPR
- B. FSK441
- C. Hellschreiber
- D. APRS

E2D01 Answer: B. The FSK441 digital mode is especially designed for use for meteor scatter signals.

Which of the following is a good technique for making meteor scatter contacts?

- A. 15 second timed transmission sequences with stations alternating based on location
- B. Use of high speed CW or digital modes
- C. Short transmission with rapidly repeated call signs and signal reports
- D. All of these choices are correct

E2D02 Answer: D. Good techniques for making meteor scatter contacts include 15 second timed transmission sequences with stations alternating based on location, use of high speed CW or digital modes, and short transmissions with rapidly repeated call signs and signal reports.

Which of the following digital modes is especially useful for EME communications?

- A. FSK441
- B. PACTOR III
- C. Olivia
- D. JT65

E2D03 Answer: D. the JT65 digital mode is especially useful for EME communications.

What is the purpose of digital store-and-forward functions on an Amateur Radio satellite?

- A. To upload operational software for the transponder
- B. To delay download of telemetry between satellites
- C. To store digital messages in the satellite for later download by other stations
- D. To relay messages between satellites

E2D04 Answer: C. The purpose of digital store-and-forward functions on an Amateur Radio satellite is to store digital messages in the satellite for later download by other stations.

Which of the following techniques is normally used by low Earth orbiting digital satellites to relay messages around the world?

- A. Digipeating
- B. Store-and-forward
- C. Multi-satellite relaying
- D. Node hopping

E2D05 Answer: B. Store-and-forward is a technique used by low Earth orbiting digital satellites to relay messages around the world.

Which of the following describes a method of establishing EME contacts?

- A. Time synchronous transmissions alternately from each station
- B. Storing and forwarding digital messages
- C. Judging optimum transmission times by monitoring beacons reflected from the Moon
- D. High speed CW identification to avoid fading

E2D06 Answer: A. Establishing EME contacts can be done by timing synchronous transmissions alternately from each station.

What digital protocol is used by APRS?

- A. PACTOR
- B. 802.11
- C. AX.25
- D. AMTOR

E2D07 Answer: C. The AX.25 digital protocol is used by APRS.

What type of packet frame is used to transmit APRS beacon data?

- A. Unnumbered Information
- B. Disconnect
- C. Acknowledgement
- D. Connect

E2D08 Answer: A. Unnumbered Information packet frames are used to transmit APRS beacon data.

Which of these digital modes has the fastest data throughput under clear communication conditions?

- A. AMTOR
- B. 170 Hz shift, 45 baud RTTY
- C. PSK31
- D. 300 baud packet

E2D09 Answer: D. 300 baud packets are faster than PSK31, 170 Hz shift, 45 baud RTTY, and AMTOR under clear communication conditions.

How can an APRS station be used to help support a public service communications activity?

- A. An APRS station with an emergency medical technician can automatically transmit medical data to the nearest hospital
- B. APRS stations with General Personnel Scanners can automatically relay the participant numbers and time as they pass the check points
- C. An APRS station with a GPS unit can automatically transmit information to show a mobile station's position during the event
- D. All of these choices are correct

E2D10 Answer: C. An APRS station can help support a public service communications activity by automatically transmitting information to show a mobile station's position during the event.

Which of the following data are used by the APRS network to communicate your location?

- A. Polar coordinates
- B. Time and frequency
- C. Radio direction finding spectrum analysis
- D. Latitude and longitude

E2D11 Answer: D. Latitude and longitude data is used by the APRS network to communicate your location.

How does JT65 improve EME communications?

- A. It can decode signals many dB below the noise floor using FEC
- B. It controls the receiver to track Doppler shift
- C. It supplies signals to guide the antenna to track the Moon
- D. All of these choices are correct

E2D12 Answer: A. JT65 improves EME communications by decoding signals many dB below the noise floor using FEC.

What type of modulation is used for JT65 contacts?

- A. Multi-tone AFSK
- B. PSK
- C. RTTY
- D. IEEE 802.11

E2D13 Answer: A. JT65 contacts use multi-tone AFSK modulation.

What is one advantage of using JT65 coding?

- A. Uses only a 65 Hz bandwidth
- B. The ability to decode signals which have a very low signal to noise ratio
- C. Easily copied by ear if necessary
- D. Permits fast-scan TV transmissions over narrow bandwidth

E2D14 Answer: B. JT65 coding has the ability to decode signals which have a very low signal to noise ratio.

E2E – Operating methods: operating HF digital modes

Which type of modulation is common for data emissions below 30 MHz?

- A. DTMF tones modulating an FM signal
- B. FSK
- C. Pulse modulation
- D. Spread spectrum

E2E01 Answer: B. FSK modulation is common for data emissions below 30 MHz.

What do the letters FEC mean as they relate to digital operation?

- A. Forward Error Correction
- B. First Error Correction
- C. Fatal Error Correction
- D. Final Error Correction

E2E02 Answer: A. The letters FEC in digital operation mean Forward Error Correction.

How is the timing of JT65 contacts organized?

- A. By exchanging ACK/NAK packets
- B. Stations take turns on alternate days
- C. Alternating transmissions at 1 minute intervals
- D. It depends on the lunar phase

E2E03 Answer: C. The timing of JT65 contacts is organized by alternating transmissions at 1 minute intervals.

What is indicated when one of the ellipses in an FSK crossed-ellipse display suddenly disappears?

- A. Selective fading has occurred
- B. One of the signal filters is saturated
- C. The receiver has drifted 5 kHz from the desired receive frequency
- D. The mark and space signal have been inverted

E2E04 Answer: A. When one of the ellipses in an FSK crossed-ellipse display suddenly disappears, it means selective fading has occurred.

Which type of digital mode does not support keyboard-to-keyboard operation?

- A. Winlink
- B. RTTY
- C. PSK31
- D. MFSK

E2E05 Answer: A. Winlink does not support keyboard-to-keyboard operation.

What is the most common data rate used for HF packet?

- A. 48 baud
- B. 110 baud
- C. 300 baud
- D. 1200 baud

E2E06 Answer: C. The most common data rate used for HF packets is 300 baud.

What is the typical bandwidth of a properly modulated MFSK16 signal?

- A. 31 Hz
- B. 316 Hz
- C. 550 Hz
- D. 2.16 kHz

E2E07 Answer: B. The typical bandwidth of a properly modulated MFSK16 signal is 316 Hz.

Which of the following HF digital modes can be used to transfer binary files?

- A. Hellschreiber
- B. PACTOR
- C. RTTY
- D. AMTOR

E2E08 Answer: B. PACTOR can be used to transfer binary files.

Which of the following HF digital modes uses variable-length coding for bandwidth efficiency?

- A. RTTY
- B. PACTOR
- C. MT63
- D. PSK31

E2E09 Answer: D. PSK31 uses variable-length coding for bandwidth efficiency.

Which of these digital modes has the narrowest bandwidth?

- A. MFSK16
- B. 170 Hz shift, 45 baud RTTY
- C. PSK31
- D. 300-baud packet

E2E10 Answer: C. PSK31 has lower bandwidth than MFSK16, 170 Hz shift, 45 baud RTTY, and 300-baud packets.

What is the difference between direct FSK and audio FSK?

- A. Direct FSK applies the data signal to the transmitter VFO
- B. Audio FSK has a superior frequency response
- C. Direct FSK uses a DC-coupled data connection
- D. Audio FSK can be performed anywhere in the transmit chain

E2E11 Answer: A. The difference between direct FSK and audio FSK is that Direct FSK applies the data signal to the transmitter VFO.

Which type of control is used by stations using the Automatic Link Enable (ALE) protocol?

- A. Local
- B. Remote
- C. Automatic
- D. ALE can use any type of control

E2E12 Answer: C. Automatic control is used by stations using the Automatic Link Enable (ALE) protocol.

Which of the following is a possible reason that attempts to initiate contact with a digital station on a clear frequency are unsuccessful?

- A. Your transmit frequency is incorrect
- B. The protocol version you are using is not the supported by the digital station
- C. Another station you are unable to hear is using the frequency
- D. All of these choices are correct

E2E13 Answer: D. Possible reasons that attempts to initiate contact with a digital station on a clear frequency are unsuccessful can include an incorrect transmit frequency, an unsupported protocol version, and another station using the same frequency.

E3 – Radio Wave Propagation

E3A – Electromagnetic waves; Earth-Moon-Earth communications; meteor scatter; microwave tropospheric and scatter propagation; aurora propagation

What is the approximate maximum separation measured along the surface of the Earth between two stations communicating by Moon bounce?

- A. 500 miles, if the Moon is at perigee
- B. 2000 miles, if the Moon is at apogee
- C. 5000 miles, if the Moon is at perigee
- D. 12,000 miles, if the Moon is visible by both stations

E3A01 Answer: D. The approximate maximum separation measured along the surface of the Earth between two stations communicating by Moon bounce is 12,000 miles, if the Moon is visible by both stations.

What characterizes libration fading of an EME signal?

- A. A slow change in the pitch of the CW signal
- B. A fluttery irregular fading
- C. A gradual loss of signal as the Sun rises
- D. The returning echo is several Hertz lower in frequency than the transmitted signal

E3A02 Answer: B. A fluttery irregular fading characterizes libration fading of an EME signal.

When scheduling EME contacts, which of these conditions will generally result in the least path loss?

- A. When the Moon is at perigee
- B. When the Moon is full
- C. When the Moon is at apogee
- D. When the MUF is above 30 MHz

E3A03 Answer: A. Scheduling EME contacts when the Moon is at perigee will generally result in the least path loss.

What do Hepburn maps predict?

- A. Sporadic E propagation
- B. Locations of auroral reflecting zones
- C. Likelihood of rain-scatter along cold or warm fronts
- D. Probability of tropospheric propagation

E3A04 Answer: D. Hepburn maps predict the probability of tropospheric propagation.

Tropospheric propagation of microwave signals often occurs along what weather related structure?

- A. Gray-line
- B. Lightning discharges
- C. Warm and cold fronts
- D. Sprites and jets

E3A05 Answer: C. Tropospheric propagation of microwave signals often occurs along warm and cold fronts.

Which of the following is required for microwave propagation via rain scatter?

- A. Rain droplets must be electrically charged
- B. Rain droplets must be within the E layer
- C. The rain must be within radio range of both stations
- D. All of these choices are correct

E3A06 Answer: C. For microwave propagation via rain scatter, the rain must be within radio range of both stations.

Atmospheric ducts capable of propagating microwave signals often form over what geographic feature?

- A. Mountain ranges
- B. Forests
- C. Bodies of water
- D. Urban areas

E3A07 Answer: C. Atmospheric ducts capable of propagating microwave signals often form over bodies of water.

When a meteor strikes the Earth's atmosphere, a cylindrical region of free electrons is formed at what layer of the ionosphere?

- A. The E layer
- B. The F1 layer
- C. The F2 layer
- D. The D layer

E3A08 Answer: A. When a meteor strikes the Earth's atmosphere, a cylindrical region of free electrons is formed at the E layer of the ionosphere.

Which of the following frequency ranges is most suited for meteor scatter communications?

- A. 1.8 MHz – 1.9 MHz
- B. 10 MHz – 14 MHz
- C. 28 MHz – 148 MHz
- D. 220 MHz – 450 MHz

E3A09 Answer: C. The 28 MHz – 148 MHz range is better suited for meteor scatter communications than 1.8 MHz – 1.9 MHz, 10 MHz – 14 MHz, or 220 MHz – 450 MHz.

Which type of atmospheric structure can create a path for microwave propagation?

- A. The jet stream
- B. Temperature inversion
- C. Wind shear
- D. Dust devil

E3A10 Answer: B. Temperature inversion can create a path for microwave propagation.

What is a typical range for tropospheric propagation of microwave signals?

- A. 10 miles to 50 miles
- B. 100 miles to 300 miles
- C. 1200 miles
- D. 2500 miles

E3A11 Answer: B. 100 miles to 300 miles is a typical range for tropospheric propagation of microwave signals.

What is the cause of auroral activity?

- A. The interaction in the F2 layer between the solar wind and the Van Allen belt
- B. A low sunspot level combined with tropospheric ducting
- C. The interaction in the E layer of charged particles from the Sun with the Earth's magnetic field
- D. Meteor showers concentrated in the extreme northern and southern latitudes

E3A12 Answer: C. The cause of auroral activity is the interaction in the E layer of charged particles from the Sun with the Earth's magnetic field.

Which emission mode is best for aurora propagation?

- A. CW
- B. SSB
- C. FM
- D. RTTY

E3A13 Answer: FM is better for aurora propagation than CW, SSB, or RTTY.

From the contiguous 48 states, in which approximate direction should an antenna be pointed to take maximum advantage of aurora propagation?

- A. South
- B. North
- C. East
- D. West

E3A14 Answer: B. From the contiguous 48 states, an antenna be pointed north to take maximum advantage of aurora propagation.

What is an electromagnetic wave?

- A. A wave of alternating current, in the core of an electromagnet
- B. A wave consisting of two electric fields at parallel right angles to each other
- C. A wave consisting of an electric field and a magnetic field oscillating at right angles to each other
- D. A wave consisting of two magnetic fields at right angles to each other

E3A15 Answer: An electromagnetic wave is a wave consisting of an electric field and a magnetic field oscillating at right angles to each other

Which of the following best describes electromagnetic waves traveling in free space?

- A. Electric and magnetic fields become aligned as they travel
- B. The energy propagates through a medium with a high refractive index
- C. The waves are reflected by the ionosphere and return to their source
- D. Changing electric and magnetic fields propagate the energy

E3A16 Answer: D. For electromagnetic waves traveling in free space, changing electric and magnetic fields propagate the energy.

What is meant by circularly polarized electromagnetic waves?

- A. Waves with an electric field bent into a circular shape
- B. Waves with a rotating electric field
- C. Waves that circle the Earth
- D. Waves produced by a loop antenna

E3A17 Answer: B. Circularly polarized electromagnetic waves are waves with a rotating electric field.

E3B – Transequatorial propagation; long path; gray-line; multi-path; ordinary and extraordinary waves; chordal hop, sporadic E mechanisms

What is transequatorial propagation?

- A. Propagation between two mid-latitude points at approximately the same distance north and south of the magnetic equator
- B. Propagation between any two points located on the magnetic equator
- C. Propagation between two continents by way of ducts along the magnetic equator
- D. Propagation between two stations at the same latitude

E3B01 Answer: A. Transequatorial propagation is propagation between two mid-latitude points at approximately the same distance north and south of the magnetic equator.

What is the approximate maximum range for signals using transequatorial propagation?

- A. 1000 miles
- B. 2500 miles
- C. 5000 miles
- D. 7500 miles

E3B02 Answer: C. The approximate maximum range for signals using transequatorial propagation is 5000 miles.

What is the best time of day for transequatorial propagation?

- A. Morning
- B. Noon
- C. Afternoon or early evening
- D. Late at night

E3B03 Answer: C. the best time of day for transequatorial propagation is afternoon or early evening.

What is meant by the terms extraordinary and ordinary waves?

- A. Extraordinary waves describe rare long skip propagation compared to ordinary waves which travel shorter distances
- B. Independent waves created in the ionosphere that are elliptically polarized
- C. Long path and short path waves
- D. Refracted rays and reflected waves

E3B04 Answer: B. Extraordinary and ordinary waves are independent waves created in the ionosphere that are elliptically polarized.

Which amateur bands typically support long-path propagation?

- A. 160 meters to 40 meters
- B. 30 meters to 10 meters
- C. 160 meters to 10 meters
- D. 6 meters to 2 meters

E3B05 Answer: C. The amateur 160 m and 10 m bands typically support long-path propagation.

Which of the following amateur bands most frequently provides long-path propagation?

- A. 80 meters
- B. 20 meters
- C. 10 meters
- D. 6 meters

E3B06 Answer: B. The amateur 20 meter band supports long-path propagation more frequently than the 6, 10, or 80 meter bands.

Which of the following could account for hearing an echo on the received signal of a distant station?

- A. High D layer absorption
- B. Meteor scatter
- C. Transmit frequency is higher than the MUF
- D. Receipt of a signal by more than one path

E3B07 Answer: D. Receipt of a signal by more than one path could account for hearing an echo on the received signal of a distant station.

What type of HF propagation is probably occurring if radio signals travel along the terminator between daylight and darkness?

- A. Transequatorial
- B. Sporadic-E
- C. Long-path
- D. Gray-line

E3B08 Answer: D. Gray-line HF propagation is probably occurring if radio signals travel along the terminator between daylight and darkness.

At what time of year is Sporadic E propagation most likely to occur?

- A. Around the solstices, especially the summer solstice
- B. Around the solstices, especially the winter solstice
- C. Around the equinoxes, especially the spring equinox
- D. Around the equinoxes, especially the fall equinox

E3B09 Answer: A. Sporadic E propagation most likely to occur around the solstices, especially the summer solstice.

What is the cause of gray-line propagation?

- A. At midday, the Sun super heats the ionosphere causing increased refraction of radio waves
- B. At twilight and sunrise, D-layer absorption is low while E-layer and F-layer propagation remains high
- C. In darkness, solar absorption drops greatly while atmospheric ionization remains steady
- D. At mid-afternoon, the Sun heats the ionosphere decreasing radio wave refraction and the MUF

E3B10 Answer: B. The cause of gray-line propagation is low D-layer absorption and high E-layer and F-layer propagation at twilight and sunrise.

At what time of day is Sporadic-E propagation most likely to occur?

- A. Around sunset
- B. Around sunrise
- C. Early evening
- D. Any time

E3B11 Answer: D. Sporadic-E propagation can occur at any time of day.

What is the primary characteristic of chordal hop propagation?

- A. Propagation away from the great circle bearing between stations
- B. Successive ionospheric reflections without an intermediate reflection from the ground
- C. Propagation across the geomagnetic equator
- D. Signals reflected back toward the transmitting station

E3B12 Answer: B. Chordal hop propagation is characterized by successive ionospheric reflections without an intermediate reflection from the ground.

Why is chordal hop propagation desirable?

- A. The signal experiences less loss along the path compared to normal skip propagation
- B. The MUF for chordal hop propagation is much lower than for normal skip propagation
- C. Atmospheric noise is lower in the direction of chordal hop propagation
- D. Signals travel faster along ionospheric chords

E3B13 Answer: A. Chordal hop propagation is desirable because the signal experiences less loss along the path compared to normal skip propagation

What happens to linearly polarized radio waves that split into ordinary and extraordinary waves in the ionosphere?

- A. They are bent toward the magnetic poles
- B. Their polarization is randomly modified
- C. They become elliptically polarized
- D. They become phase-locked

E3B14 Answer: C. Linearly polarized radio waves that split into ordinary and extraordinary waves in the ionosphere become elliptically polarized.

E3C – Radio-path horizon; less common propagation modes; propagation prediction techniques and modeling; space weather parameters and amateur radio

What does the term ray tracing describe in regard to radio communications?

- A. The process in which an electronic display presents a pattern
- B. Modeling a radio wave's path through the ionosphere
- C. Determining the radiation pattern from an array of antennas
- D. Evaluating high voltage sources for X-Rays

E3C01 Answer: B. Ray tracing is modeling a radio wave's path through the ionosphere.

What is indicated by a rising A or K index?

- A. Increasing disruption of the geomagnetic field
- B. Decreasing disruption of the geomagnetic field
- C. Higher levels of solar UV radiation
- D. An increase in the critical frequency

E3C02 Answer: A. A rising A or K index indicates increasing disruption of the geomagnetic field.

Which of the following signal paths is most likely to experience high levels of absorption when the A index or K index is elevated?

- A. Transequatorial propagation
- B. Polar paths
- C. Sporadic-E
- D. NVIS

E3C03 Answer: B. Polar paths are more likely to experience high levels of absorption when the A index or K index is elevated than transequatorial propagation, sporadic-E propagation, and NVIS propagation.

What does the value of Bz (B sub Z) represent?

- A. Geomagnetic field stability
- B. Critical frequency for vertical transmissions
- C. Direction and strength of the interplanetary magnetic field
- D. Duration of long-delayed echoes

E3C04 Answer: C. Bz represents the direction and strength of the interplanetary magnetic field.

What orientation of Bz (B sub z) increases the likelihood that incoming particles from the Sun will cause disturbed conditions?

- A. Southward
- B. Northward
- C. Eastward
- D. Westward

E3C05 Answer: A. A southward orientation of Bz increases the likelihood that incoming particles from the Sun will cause disturbed conditions.

By how much does the VHF/UHF radio horizon distance exceed the geometric horizon?

- A. By approximately 15 percent of the distance
- B. By approximately twice the distance
- C. By approximately 50 percent of the distance
- D. By approximately four times the distance

E3C06 Answer: A. The VHF/UHF radio horizon distance exceeds the geometric horizon by approximately 15 percent of the distance.

Which of the following descriptors indicates the greatest solar flare intensity?

- A. Class A
- B. Class B
- C. Class M
- D. Class X

E3C07 Answer: D. A class X descriptor indicates the greatest solar flare intensity.

What does the space weather term G5 mean?

- A. An extreme geomagnetic storm
- B. Very low solar activity
- C. Moderate solar wind
- D. Waning sunspot numbers

E3C08 Answer: A. The space weather term G5 indicates an extreme geomagnetic storm.

How does the intensity of an X3 flare compare to that of an X2 flare?

- A. 10 percent greater
- B. 50 percent greater
- C. Twice as great
- D. Four times as great

E3C09 Answer: C. An X3 flare is twice as great as an X2 flare.

What does the 304A solar parameter measure?

- A. The ratio of X-Ray flux to radio flux, correlated to sunspot number
- B. UV emissions at 304 angstroms, correlated to solar flux index
- C. The solar wind velocity at 304 degrees from the solar equator, correlated to solar activity
- D. The solar emission at 304 GHz, correlated to X-Ray flare levels

E3C10 Answer: B. The 304A solar parameter measures UV emissions at 304 angstroms, correlated to solar flux index.

What does VOACAP software model?

- A. AC voltage and impedance
- B. VHF radio propagation
- C. HF propagation
- D. AC current and impedance

E3C11 Answer: C. VOACAP software models HF propagation.

How does the maximum distance of ground-wave propagation change when the signal frequency is increased?

- A. It stays the same
- B. It increases
- C. It decreases
- D. It peaks at roughly 14 MHz

E3C12 Answer: C. The maximum distance of ground-wave propagation decreases when the signal frequency is increased.

What type of polarization is best for ground-wave propagation?

- A. Vertical
- B. Horizontal
- C. Circular
- D. Elliptical

E3C13 Answer: A. Vertical polarization is best for ground-wave propagation.

Why does the radio-path horizon distance exceed the geometric horizon?

- A. E-region skip
- B. D-region skip
- C. Downward bending due to aurora refraction
- D. Downward bending due to density variations in the atmosphere

E3C14 Answer: D. The radio-path horizon distance exceeds the geometric horizon due to downward bending due to density variations in the atmosphere.

What might a sudden rise in radio background noise indicate?

- A. A meteor ping
- B. A solar flare has occurred
- C. Increased transequatorial propagation likely
- D. Long-path propagation is occurring

E3C15 Answer: B. A sudden rise in radio background noise might indicate that a solar flare has occurred.

E4 – Amateur Practices

E4A – Test equipment: analog and digital instruments; spectrum and network analyzers, antenna analyzers; oscilloscopes; RF measurements; computer aided measurements

Which of the following parameter determines the bandwidth of a digital or computer-based oscilloscope?

- A. Input capacitance
- B. Input impedance
- C. Sampling rate
- D. Sample resolution

E4A01 Answer: C. Sampling rate determines the bandwidth of a digital or computer-based oscilloscope.

Which of the following parameters would a spectrum analyzer display on the vertical and horizontal axes?

- A. RF amplitude and time
- B. RF amplitude and frequency
- C. SWR and frequency
- D. SWR and time

E4A02 Answer: B. a spectrum analyzer would display RF amplitude and frequency on the vertical and horizontal axes, respectively.

Which of the following test instrument is used to display spurious signals and/or intermodulation distortion products in an SSB transmitter?

- A. A wattmeter
- B. A spectrum analyzer
- C. A logic analyzer
- D. A time-domain reflectometer

E4A03 Answer: B. A spectrum analyzer is used to display spurious signals and/or intermodulation distortion products in an SSB transmitter.

What determines the upper frequency limit for a computer sound-card-based oscilloscope program?

- A. Analog-to-digital conversion speed of the soundcard
- B. Amount of memory on the soundcard
- C. Q of the interface of the interface circuit
- D. All of these choices are correct

E4A04 Answer: A. The analog-to-digital conversion speed of the sound card determines the upper frequency limit of a computer sound-card-based oscilloscope program.

What might be an advantage of a digital vs. an analog oscilloscope?

- A. Automatic amplitude and frequency numerical readout
- B. Storage of traces for future reference
- C. Manipulation of time base after trace capture
- D. All of these choices are correct

E4A05 Answer: D. Digital oscilloscopes have many advantages over analog oscilloscopes, including automatic amplitude and frequency readouts, onboard storage of traces, and manipulation of time bases after trace capture.

What is the effect of aliasing in a digital or computer-based oscilloscope?

- A. False signals are displayed
- B. All signals will have a DC offset
- C. Calibration of the vertical scale is no longer valid
- D. False triggering occurs

E4A06 Answer: A. Aliasing in a digital or computer-based oscilloscope means that false signals are being displayed.

Which of the following is an advantage of using an antenna analyzer compared to an SWR bridge to measure antenna SWR?

- A. Antenna analyzers automatically tune your antenna for resonance
- B. Antenna analyzers do not need an external RF source
- C. Antenna analyzers display a time-varying representation of the modulation envelope
- D. All of these choices are correct

E4A07 Answer: B. An advantage of using an antenna analyzer compared to an SWR bridge to measure antenna SWR is that antenna analyzers do not need an external RF source.

Which of the following instruments would be best for measuring the SWR of a beam antenna?

- A. A spectrum analyzer
- B. A Q meter
- C. An ohmmeter
- D. An antenna analyzer

E4A08 Answer: D. An antenna analyzer would be best for measuring the SWR of a beam antenna.

When using a computer's soundcard input to digitize signals, what is the highest frequency signal that can be digitized without aliasing?

- A. The same as the sample rate
- B. One-half the sample rate
- C. One-tenth the sample rate
- D. It depends on how the data is stored internally

E4A09 Answer: B. When using a computer's soundcard input to digitize signals, the highest frequency signal that can be digitized without aliasing is one-half the sample rate.

Which of the following displays multiple digital signal states simultaneously?

- A. Network analyzer
- B. Bit error rate tester
- C. Modulation monitor
- D. Logic analyzer

E4A10 Answer: D. A logic analyzer displays multiple digital signal states simultaneously.

Which of the following is good practice when using an oscilloscope probe?

- A. Keep the signal ground connection of the probe as short as possible
- B. Never use a high impedance probe to measure a low impedance circuit
- C. Never use a DC-coupled probe to measure an AC circuit
- D. All of these choices are correct

E4A11 Answer: A. When using an oscilloscope probe, you should keep the signal ground connection of the probe as short as possible.

Which of the following procedures is an important precaution to follow when connecting a spectrum analyzer to a transmitter output?

- A. Use high quality double shielded coaxial cables to reduce signal losses
- B. Attenuate the transmitter output going to the spectrum analyzer
- C. Match the antenna to the load
- D. All of these choices are correct

E4A12 Answer: B. When connecting a spectrum analyzer to a transmitter output, you should attenuate the transmitter output going to the spectrum analyzer

How is the compensation of an oscilloscope probe typically adjusted?

- A. A square wave is displayed and the probe is adjusted until the horizontal portions of the displayed wave are as nearly flat as possible
- B. A high frequency sine wave is displayed and the probe is adjusted for maximum amplitude
- C. A frequency standard is displayed and the probe is adjusted until the deflection time is accurate
- D. A DC voltage standard is displayed and the probe is adjusted until the displayed voltage is accurate

E4A13 Answer: A. An oscilloscope probe is typically adjusted by displaying a square wave and adjusting the probe until the horizontal portions of the displayed wave are as nearly flat as possible.

What is the purpose of the prescaler function on a frequency counter?

- A. It amplifies low level signals for more accurate counting
- B. It multiplies a higher frequency signal so a low-frequency counter can display the operating frequency
- C. It prevents oscillation in a low-frequency counter circuit
- D. It divides a higher frequency signal so a low-frequency counter can display the input frequency

E4A14 Answer: D. The prescaler function on a frequency counter divides a higher frequency signal so a low-frequency counter can display the input frequency.

What is an advantage of a period-measuring frequency counter over a direct-count type?

- A. It can run on battery power for remote measurements
- B. It does not require an expensive high-precision time base
- C. It provides improved resolution of low-frequency signals within a comparable time period
- D. It can directly measure the modulation index of an FM transmitter

E4A15 Answer: C. An advantage of a period-measuring frequency counter over a direct-count type is that it provides improved resolution of low-frequency signals within a comparable time period.

E4B – Measurement technique and limitations: instrument accuracy and performance limitations; probes; techniques to minimize errors; measurement of "Q"; instrument calibration; S parameters; vector network analyzers

Which of the following factors most affects the accuracy of a frequency counter?

- A. Input attenuator accuracy
- B. Time base accuracy
- C. Decade divider accuracy
- D. Temperature coefficient of the logic

E4B01 Answer: B. Time base accuracy most affects the overall accuracy of a frequency counter.

What is an advantage of using a bridge circuit to measure impedance?

- A. It provides an excellent match under all conditions
- B. It is relatively immune to drift in the signal generator source
- C. It is very precise in obtaining a signal null
- D. It can display results directly in Smith chart format

E4B02 Answer: C. An advantage of using a bridge circuit to measure impedance is that it is very precise in obtaining a signal null.

If a frequency counter with a specified accuracy of +/- 1.0 ppm reads 146,520,000 Hz, what is the most the actual frequency being measured could differ from the reading?

- A. 165.2 Hz
- B. 14.652 kHz
- C. 146.52 Hz
- D. 1.4652 MHz

E4B03 Answer: C. The most the actual frequency being measured could differ from the reading would be 146.52 Hz.

If a frequency counter with a specified accuracy of +/- 0.1 ppm reads 146,520,000 Hz, what is the most the actual frequency being measured could differ from the reading?

- A. 14.652 Hz
- B. 0.1 MHz
- C. 1.4652 Hz
- D. 1.4652 kHz

E4B04 Answer: A. The most the actual frequency being measured could differ from the reading would be 14.652 Hz.

If a frequency counter with a specified accuracy of +/- 10 ppm reads 146,520,000 Hz, what is the most the actual frequency being measured could differ from the reading?

- A. 146.52 Hz
- B. 10 Hz
- C. 146.52 kHz
- D. 1465.20 Hz

E4B05 Answer: D. The most the actual frequency being measured could differ from the reading would be 1465.20 Hz.

How much power is being absorbed by the load when a directional power meter connected between a transmitter and a terminating load reads 100 watts forward power and 25 watts reflected power?

- A. 100 watts
- B. 125 watts
- C. 25 watts
- D. 75 watts

E4B06 Answer: D. 75 watts of power are being absorbed by the load when a directional power meter connected between a transmitter and a terminating load reads 100 watts forward power and 25 watts reflected power.

What do the subscripts of S parameters represent?

- A. The port or ports at which measurements are made
- B. The relative time between measurements
- C. Relative quality of the data
- D. Frequency order of the measurements

E4B07 Answer: A. The subscripts of S parameters represent the port or ports at which measurements are made.

Which of the following is a characteristic of a good DC voltmeter?

- A. High reluctance input
- B. Low reluctance input
- C. High impedance input
- D. Low impedance input

E4B08 Answer: C. High impedance input is a characteristic of a good DC voltmeter.

What is indicated if the current reading on an RF ammeter placed in series with the antenna feed line of a transmitter increases as the transmitter is tuned to resonance?

- A. There is possibly a short to ground in the feed line
- B. The transmitter is not properly neutralized
- C. There is an impedance mismatch between the antenna and feed line
- D. There is more power going into the antenna

E4B09 Answer: D. If the current reading on an RF ammeter placed in series with the antenna feed line of a transmitter increases as the transmitter is tuned to resonance, it indicates there is more power going into the antenna.

Which of the following describes a method to measure intermodulation distortion in an SSB transmitter?

- A. Modulate the transmitter with two non-harmonically related radio frequencies and observe the RF output with a spectrum analyzer
- B. Modulate the transmitter with two non-harmonically related audio frequencies and observe the RF output with a spectrum analyzer
- C. Modulate the transmitter with two harmonically related audio frequencies and observe the RF output with a peak reading wattmeter
- D. Modulate the transmitter with two harmonically related audio frequencies and observe the RF output with a logic analyzer

E4B10 Answer: B. Intermodulation distortion in an SSB transmitter can be measured by modulating the transmitter with two non-harmonically related audio frequencies and observing the RF output with a spectrum analyzer.

How should an antenna analyzer be connected when measuring antenna resonance and feed point impedance?

- A. Loosely couple the analyzer near the antenna base
- B. Connect the analyzer via a high-impedance transformer to the antenna
- C. Loosely couple the antenna and a dummy load to the analyzer
- D. Connect the antenna feed line directly to the analyzer's connector

E4B11 Answer: D. An antenna analyzer should be connected directly to the antenna feed line when measuring antenna resonance and feed point impedance.

What is the significance of voltmeter sensitivity expressed in ohms per volt?

- A. The full scale reading of the voltmeter multiplied by its ohms per volt rating will indicate the input impedance of the voltmeter
- B. When used as a galvanometer, the reading in volts multiplied by the ohms per volt rating will determine the power drawn by the device under test
- C. When used as an ohmmeter, the reading in ohms divided by the ohms per volt rating will determine the voltage applied to the circuit
- D. When used as an ammeter, the full scale reading in amps divided by ohms per volt rating will determine the size of shunt needed

E4B12 Answer: A. Voltmeter sensitivity is expressed in ohms per volt because the full scale reading of the voltmeter multiplied by its ohms per volt rating will indicate the input impedance of the voltmeter.

Which S parameter is equivalent to forward gain?

- A. S11
- B. S12
- C. S21
- D. S22

E4B13 Answer: C. The S21 parameter is equivalent to forward gain.

What happens if a dip meter is too tightly coupled to a tuned circuit being checked?

- A. Harmonics are generated
- B. A less accurate reading results
- C. Cross modulation occurs
- D. Intermodulation distortion occurs

E4B14 Answer: B. If a dip meter is too tightly coupled to a tuned circuit being checked, a less accurate reading results.

Which of the following can be used as a relative measurement of the Q for a series-tuned circuit?

- A. The inductance to capacitance ratio
- B. The frequency shift
- C. The bandwidth of the circuit's frequency response
- D. The resonant frequency of the circuit

E4B15 Answer: C. The bandwidth of the circuit's frequency response can be used as a relative measurement of the Q for a series-tuned circuit.

Which S parameter represents return loss or SWR?

- A. S11
- B. S12
- C. S21
- D. S22

E4B16 Answer: A. The S11 parameter represents return loss or SWR.

What three test loads are used to calibrate a standard RF vector network analyzer?

- A. 50 ohms, 75 ohms, and 90 ohms
- B. Short circuit, open circuit, and 50 ohms
- C. Short circuit, open circuit, and resonant circuit
- D. 50 ohms through $1/8$ wavelength, $1/4$ wavelength, and $1/2$ wavelength of coaxial cable

E4B17 Answer: B. Short circuit, open circuit, and 50 ohms test loads are used to calibrate a standard RF vector network analyzer.

E4C – Receiver performance characteristics, phase noise, noise floor, image rejection, MDS, signal-to-noise-ratio; selectivity; effects of SDR receiver non-linearity

What is an effect of excessive phase noise in the local oscillator section of a receiver?

- A. It limits the receiver's ability to receive strong signals
- B. It reduces receiver sensitivity
- C. It decreases receiver third-order intermodulation distortion dynamic range
- D. It can cause strong signals on nearby frequencies to interfere with reception of weak signals

E4C01 Answer: D. Excessive phase noise in the local oscillator section of a receiver can cause strong signals on nearby frequencies to interfere with reception of weak signals.

Which of the following portions of a receiver can be effective in eliminating image signal interference?

- A. A front-end filter or pre-selector
- B. A narrow IF filter
- C. A notch filter
- D. A properly adjusted product detector

E4C02 Answer: A. A front-end filter or pre-selector can be effective in eliminating image signal interference.

What is the term for the blocking of one FM phone signal by another, stronger FM phone signal?

- A. Desensitization
- B. Cross-modulation interference
- C. Capture effect
- D. Frequency discrimination

E4C03 Answer: C. Capture effect is the term for the blocking of one FM phone signal by another, stronger FM phone signal.

How is the noise figure of a receiver defined?

- A. The ratio of atmospheric noise to phase noise
- B. The ratio of the noise bandwidth in Hertz to the theoretical bandwidth of a resistive network
- C. The ratio of thermal noise to atmospheric noise
- D. The ratio in dB of the noise generated by the receiver to the theoretical minimum noise

E4C04 Answer: D. The noise figure of a receiver is defined as the ratio in dB of the noise generated by the receiver to the theoretical minimum noise.

What does a value of -174 dBm/Hz represent with regard to the noise floor of a receiver?

- A. The minimum detectable signal as a function of receive frequency
- B. The theoretical noise at the input of a perfect receiver at room temperature
- C. The noise figure of a 1 Hz bandwidth receiver
- D. The galactic noise contribution to minimum detectable signal

E4C05 Answer: B. A value of -174 dBm/Hz represents the theoretical noise at the input of a perfect receiver at room temperature.

A CW receiver with the AGC off has an equivalent input noise power density of -174 dBm/Hz. What would be the level of an unmodulated carrier input to this receiver that would yield an audio output SNR of 0 dB in a 400 Hz noise bandwidth?

- A. -174 dBm
- B. -164 dBm
- C. -155 dBm
- D. -148 dBm

E4C06 Answer: D. -148 dBm is the level of an unmodulated carrier input to this receiver that would yield an audio output SNR of 0 dB in a 400 Hz noise bandwidth.

What does the MDS of a receiver represent?

- A. The meter display sensitivity
- B. The minimum discernible signal
- C. The multiplex distortion stability
- D. The maximum detectable spectrum

E4C07 Answer: B. The MDS of a receiver represents the minimum discernible signal.

An SDR receiver is overloaded when input signals exceed what level?

- A. One-half the maximum sample rate
- B. One-half the maximum sampling buffer size
- C. The maximum count value of the analog-to-digital converter
- D. The reference voltage of the analog-to-digital converter

E4C08 Answer: C. An SDR receiver is overloaded when input signals exceed the maximum count value of the analog-to-digital converter.

Which of the following choices is a good reason for selecting a high frequency for the design of the IF in a conventional HF or VHF communications receiver?

- A. Fewer components in the receiver
- B. Reduced drift
- C. Easier for front-end circuitry to eliminate image responses
- D. Improved receiver noise figure

E4C09 Answer: C. It is a good reason to select a high frequency for the design of the IF in a conventional HF or VHF communications receiver because it makes it easier for front-end circuitry to eliminate image responses.

Which of the following is a desirable amount of selectivity for an amateur RTTY HF receiver?

- A. 100 Hz
- B. 300 Hz
- C. 6000 Hz
- D. 2400 Hz

E4C10 Answer: B. 300 Hz is a desirable amount of selectivity for an amateur RTTY HF receiver.

Which of the following is a desirable amount of selectivity for an amateur SSB phone receiver?

- A. 1 kHz
- B. 2.4 kHz
- C. 4.2 kHz
- D. 4.8 kHz

E4C11 Answer: B. 2.4 kHz is a desirable amount of selectivity for an amateur SSB phone receiver.

What is an undesirable effect of using too wide a filter bandwidth in the IF section of a receiver?

- A. Output-offset overshoot
- B. Filter ringing
- C. Thermal-noise distortion
- D. Undesired signals may be heard

E4C12 Answer: D. Using too wide a filter bandwidth in the IF section of a receiver may result in undesired signals being heard.

How does a narrow-band roofing filter affect receiver performance?

- A. It improves sensitivity by reducing front end noise
- B. It improves intelligibility by using low Q circuitry to reduce ringing
- C. It improves dynamic range by attenuating strong signals near the receive frequency
- D. All of these choices are correct

E4C13 Answer: C. A narrow-band roofing filter affects receiver performance improving dynamic range by attenuating strong signals near the receive frequency.

What transmit frequency might generate an image response signal in a receiver tuned to 14.300 MHz and which uses a 455 kHz IF frequency?

- A. 13.845 MHz
- B. 14.755 MHz
- C. 14.445 MHz
- D. 15.210 MHz

E4C14 Answer: D. A 15.210 MHz transmit frequency might generate an image response signal in a receiver tuned to 14.300 MHz and which uses a 455 kHz IF frequency.

What is usually the primary source of noise that is heard from an HF receiver with an antenna connected?

- A. Detector noise
- B. Induction motor noise
- C. Receiver front-end noise
- D. Atmospheric noise

E4C15 Answer: D. Atmospheric noise is usually the primary source of noise that is heard from an HF receiver with an antenna connected.

Which of the following is caused by missing codes in an SDR receiver's analog-to-digital converter?

- A. Distortion
- B. Overload
- C. Loss of sensitivity
- D. Excess output level

E4C16 Answer: A. Distortion is caused by missing codes in an SDR receiver's analog-to-digital converter.

Which of the following has the largest effect on an SDR receiver's linearity?

- A. CPU register width in bits
- B. Anti-aliasing input filter bandwidth
- C. RAM speed used for data storage
- D. Analog-to-digital converter sample width in bits

E4C17 Answer: D. Analog-to-digital converter sample width in bits has the largest effect on an SDR receiver's linearity.

E4D – Receiver performance characteristics: blocking dynamic range; intermodulation and cross-modulation interference; 3rd order intercept; desensitization; preselector

What is meant by the blocking dynamic range of a receiver?

- A. The difference in dB between the noise floor and the level of an incoming signal which will cause 1 dB of gain compression
- B. The minimum difference in dB between the levels of two FM signals which will cause one signal to block the other
- C. The difference in dB between the noise floor and the third order intercept point
- D. The minimum difference in dB between two signals which produce third order intermodulation products greater than the noise floor

E4D01 Answer: A. The blocking dynamic range of a receiver is the difference in dB between the noise floor and the level of an incoming signal which will cause 1 dB of gain compression

Which of the following describes two problems caused by poor dynamic range in a communications receiver?

- A. Cross-modulation of the desired signal and desensitization from strong adjacent signals
- B. Oscillator instability requiring frequent retuning and loss of ability to recover the opposite sideband
- C. Cross-modulation of the desired signal and insufficient audio power to operate the speaker
- D. Oscillator instability and severe audio distortion of all but the strongest received signals

E4D02 Answer: A. Cross-modulation of the desired signal and desensitization from strong adjacent signals are both problems caused by poor dynamic range in a communications receiver.

How can intermodulation interference between two repeaters occur?

- A. When the repeaters are in close proximity and the signals cause feedback in the final amplifier of one or both transmitters
- B. When the repeaters are in close proximity and the signals mix in the final amplifier of one or both transmitters
- C. When the signals from the transmitters are reflected out of phase from airplanes passing overhead
- D. When the signals from the transmitters are reflected in phase from airplanes passing overhead

E4D03 Answer: B. Intermodulation interference between two repeaters can occur when the repeaters are in close proximity and the signals mix in the final amplifier of one or both transmitters.

Which of the following may reduce or eliminate intermodulation interference in a repeater caused by another transmitter operating in close proximity?

- A. A band-pass filter in the feed line between the transmitter and receiver
- B. A properly terminated circulator at the output of the transmitter
- C. A Class C final amplifier
- D. A Class D final amplifier

E4D04 Answer: B. A properly terminated circulator at the output of the transmitter may reduce or eliminate intermodulation interference in a repeater caused by another transmitter operating in close proximity.

What transmitter frequencies would cause an intermodulation-product signal in a receiver tuned to 146.70 MHz when a nearby station transmits on 146.52 MHz?

- A. 146.34 MHz and 146.61 MHz
- B. 146.88 MHz and 146.34 MHz
- C. 146.10 MHz and 147.30 MHz
- D. 173.35 MHz and 139.40 MHz

E4D05 Answer: A. 146.34 MHz and 146.61 MHz frequencies would cause an intermodulation-product signal in a receiver tuned to 146.70 MHz when a nearby station transmits on 146.52 MHz.

What is the term for unwanted signals generated by the mixing of two or more signals?

- A. Amplifier desensitization
- B. Neutralization
- C. Adjacent channel interference
- D. Intermodulation interference

E4D06 Answer: D. Intermodulation interference is an unwanted signal generated by the mixing of two or more signals.

Which describes the most significant effect of an off-frequency signal when it is causing cross-modulation interference to a desired signal?

- A. A large increase in background noise
- B. A reduction in apparent signal strength
- C. The desired signal can no longer be heard
- D. The off-frequency unwanted signal is heard in addition to the desired signal

E4D07 Answer: D. When an off-frequency signal is causing cross-modulation interference to a desired signal, the off-frequency signal is heard in addition to the desired signal.

What causes intermodulation in an electronic circuit?

- A. Too little gain
- B. Lack of neutralization
- C. Nonlinear circuits or devices
- D. Positive feedback

E4D08 Answer: C. Nonlinear circuits or devices cause intermodulation in an electronic circuit.

What is the purpose of the preselector in a communications receiver?

- A. To store often-used frequencies
- B. To provide a range of AGC time constants
- C. To increase rejection of unwanted signals
- D. To allow selection of the optimum RF amplifier device

E4D09 Answer: C. The purpose of the preselector in a communications receiver is to increase rejection of unwanted signals.

What does a third-order intercept level of 40 dBm mean with respect to receiver performance?

- A. Signals less than 40 dBm will not generate audible third-order intermodulation products
- B. The receiver can tolerate signals up to 40 dB above the noise floor without producing third-order intermodulation products
- C. A pair of 40 dBm signals will theoretically generate a third-order intermodulation product with the same level as the input signals
- D. A pair of 1 mW input signals will produce a third-order intermodulation product which is 40 dB stronger than the input signal

E4D10 Answer: C. A third-order intercept level of 40 dBm means that a pair of 40 dBm signals will theoretically generate a third-order intermodulation product with the same level as the input signals.

Why are third-order intermodulation products created within a receiver of particular interest compared to other products?

- A. The third-order product of two signals which are in the band of interest is also likely to be within the band
- B. The third-order intercept is much higher than other orders
- C. Third-order products are an indication of poor image rejection
- D. Third-order intermodulation produces three products for every input signal within the band of interest

E4D11 Answer: A. Third-order intermodulation products created within a receiver of particular interest are often compared to other products because the third-order product of two signals which are in the band of interest is also likely to be within the band.

What is the term for the reduction in receiver sensitivity caused by a strong signal near the received frequency?

- A. Desensitization
- B. Quieting
- C. Cross-modulation interference
- D. Squelch gain rollback

E4D12 Answer: A. Desensitization is the reduction in receiver sensitivity caused by a strong signal near the received frequency.

Which of the following can cause receiver desensitization?

- A. Audio gain adjusted too low
- B. Strong adjacent channel signals
- C. Audio bias adjusted too high
- D. Squelch gain misadjusted

E4D13 Answer: B. Strong adjacent channel signals can cause receiver desensitization.

Which of the following is a way to reduce the likelihood of receiver desensitization?

- A. Decrease the RF bandwidth of the receiver
- B. Raise the receiver IF frequency
- C. Increase the receiver front end gain
- D. Switch from fast AGC to slow AGC

E4D14 Answer: A. Decreasing the RF bandwidth of the receiver is a way to reduce the likelihood of receiver desensitization.

E4E – Noise suppression: system noise; electrical appliance noise; line noise; locating noise sources; DSP noise reduction; noise blankers; grounding for signals

Which of the following types of receiver noise can often be reduced by use of a receiver noise blanker?

- A. Ignition noise
- B. Broadband white noise
- C. Heterodyne interference
- D. All of these choices are correct

E4E01 Answer: A. Ignition noise can often be reduced by use of a receiver noise blanker.

Which of the following types of receiver noise can often be reduced with a DSP noise filter?

- A. Broadband white noise
- B. Ignition noise
- C. Power line noise
- D. All of these choices are correct

E4E02 Answer: D. Broadband white noise, ignition noise, and power line noise can often be reduced with a DSP noise filter.

Which of the following signals might a receiver noise blanker be able to remove from desired signals?

- A. Signals which are constant at all IF levels
- B. Signals which appear across a wide bandwidth
- C. Signals which appear at one IF but not another
- D. Signals which have a sharply peaked frequency distribution

E4E03 Answer: B. A receiver noise blanker might be able to remove signals which appear across a wide bandwidth from desired signals.

How can conducted and radiated noise caused by an automobile alternator be suppressed?

- A. By installing filter capacitors in series with the DC power lead and a blocking capacitor in the field lead
- B. By installing a noise suppression resistor and a blocking capacitor in both leads
- C. By installing a high-pass filter in series with the radio's power lead and a low-pass filter in parallel with the field lead
- D. By connecting the radio's power leads directly to the battery and by installing coaxial capacitors in line with the alternator leads

E4E04 Answer: D. Conducted and radiated noise caused by an automobile alternator can be suppressed by connecting the radio's power leads directly to the battery and by installing coaxial capacitors in line with the alternator leads.

How can noise from an electric motor be suppressed?

- A. By installing a high pass filter in series with the motor's power leads
- B. By installing a brute-force AC-line filter in series with the motor leads
- C. By installing a bypass capacitor in series with the motor leads
- D. By using a ground-fault current interrupter in the circuit used to power the motor

E4E05 Answer: B. Noise from an electric motor can be suppressed by installing a brute-force AC-line filter in series with the motor leads.

What is a major cause of atmospheric static?

- A. Solar radio frequency emissions
- B. Thunderstorms
- C. Geomagnetic storms
- D. Meteor showers

E4E06 Answer: B. Thunderstorms are a major cause of atmospheric static.

How can you determine if line noise interference is being generated within your home?

- A. By checking the power line voltage with a time domain reflectometer
- B. By observing the AC power line waveform with an oscilloscope
- C. By turning off the AC power line main circuit breaker and listening on a battery operated radio
- D. By observing the AC power line voltage with a spectrum analyzer

E4E07 Answer: You can determine if line noise interference is being generated within your home by turning off the AC power line main circuit breaker and listening on a battery operated radio.

What type of signal is picked up by electrical wiring near a radio antenna?

- A. A common-mode signal at the frequency of the radio transmitter
- B. An electrical-sparking signal
- C. A differential-mode signal at the AC power line frequency
- D. Harmonics of the AC power line frequency

E4E08 Answer: A. A common-mode signal at the frequency of the radio transmitter is picked up by electrical wiring near a radio antenna.

What undesirable effect can occur when using an IF noise blanker?

- A. Received audio in the speech range might have an echo effect
- B. The audio frequency bandwidth of the received signal might be compressed
- C. Nearby signals may appear to be excessively wide even if they meet emission standards
- D. FM signals can no longer be demodulated

E4E09 Answer: C. When using an IF noise blanker, nearby signals may appear to be excessively wide even if they meet emission standards.

What is a common characteristic of interference caused by a touch controlled electrical device?

- A. The interfering signal sounds like AC hum on an AM receiver or a carrier modulated by 60 Hz hum on a SSB or CW receiver
- B. The interfering signal may drift slowly across the HF spectrum
- C. The interfering signal can be several kHz in width and usually repeats at regular intervals across a HF band
- D. All of these choices are correct

E4E10 Answer: D. Touch-controlled electrical devices may cause interference that sounds like AC hum on an AM receiver or a carrier modulated by 60 Hz hum on a SSB or CW receiver, interference that drifts slowly across the HF spectrum, and interference that can be several kHz in width and repeats at regular intervals across a HF band.

Which is the most likely cause if you are hearing combinations of local AM broadcast signals within one or more of the MF or HF ham bands?

- A. The broadcast station is transmitting an over-modulated signal
- B. Nearby corroded metal joints are mixing and re-radiating the broadcast signals
- C. You are receiving sky wave signals from a distant station
- D. Your station receiver IF amplifier stage is defective

E4E11 Answer: B. If you are hearing combinations of local AM broadcast signals within one or more of the MF or HF ham bands, it is likely that nearby corroded metal joints are mixing and re-radiating the broadcast signals.

What is one disadvantage of using some types of automatic DSP notch-filters when attempting to copy CW signals?

- A. A DSP filter can remove the desired signal at the same time as it removes interfering signals
- B. Any nearby signal passing through the DSP system will overwhelm the desired signal
- C. Received CW signals will appear to be modulated at the DSP clock frequency
- D. Ringing in the DSP filter will completely remove the spaces between the CW characters

E4E12 Answer: A. A disadvantage of using some types of automatic DSP notch-filters when attempting to copy CW signals is that a DSP filter can remove the desired signal at the same time as it removes interfering signals.

What might be the cause of a loud roaring or buzzing AC line interference that comes and goes at intervals?

- A. Arcing contacts in a thermostatically controlled device
- B. A defective doorbell or doorbell transformer inside a nearby residence
- C. A malfunctioning illuminated advertising display
- D. All of these choices are correct

E4E13 Answer: D. Loud roaring or buzzing AC line interference that comes and goes at intervals could be caused by a number of things, including arcing contacts in a thermostatically controlled device, a defective doorbell or doorbell transformer inside a nearby residence, or a malfunctioning illuminated advertising display.

What is one type of electrical interference that might be caused by the operation of a nearby personal computer?

- A. A loud AC hum in the audio output of your station receiver
- B. A clicking noise at intervals of a few seconds
- C. The appearance of unstable modulated or unmodulated signals at specific frequencies
- D. A whining type noise that continually pulses off and on

E4E14 Answer: C. The appearance of unstable modulated or unmodulated signals at specific frequencies could be caused by the operation of a nearby personal computer.

Which of the following can cause shielded cables to radiate or receive interference?

- A. Low inductance ground connections at both ends of the shield
- B. Common mode currents on the shield and conductors
- C. Use of braided shielding material
- D. Tying all ground connections to a common point resulting in differential mode currents in the shield

E4E15 Answer: B. Common mode currents on the shield and conductors can cause shielded cables to radiate or receive interference.

What current flows equally on all conductors of an unshielded multi-conductor cable?

- A. Differential-mode current
- B. Common-mode current
- C. Reactive current only
- D. Return current

E4E16 Answer: B. Common-mode current flows equally on all conductors of an unshielded multi-conductor cable.

E5 – Electrical Principles

E5A – Resonance and Q: characteristics of resonant circuits: series and parallel resonance; definitions and effects of Q; half-power bandwidth; phase relationships in reactive circuits

What can cause the voltage across reactances in series to be larger than the voltage applied to them?

- A. Resonance
- B. Capacitance
- C. Conductance
- D. Resistance

E5A01 Answer: A. Resonance can cause the voltage across reactances in series to be larger than the voltage applied to them.

What is resonance in an electrical circuit?

- A. The highest frequency that will pass current
- B. The lowest frequency that will pass current
- C. The frequency at which the capacitive reactance equals the inductive reactance
- D. The frequency at which the reactive impedance equals the resistive impedance

E5A02 Answer: C. Resonance in an electrical circuit is the frequency at which the capacitive reactance equals the inductive reactance.

What is the magnitude of the impedance of a series RLC circuit at resonance?

- A. High, as compared to the circuit resistance
- B. Approximately equal to capacitive reactance
- C. Approximately equal to inductive reactance
- D. Approximately equal to circuit resistance

E5A03 Answer: D. The magnitude of the impedance of a series RLC circuit at resonance is approximately equal to circuit resistance.

What is the magnitude of the impedance of a circuit with a resistor, an inductor and a capacitor all in parallel, at resonance?

- A. Approximately equal to circuit resistance
- B. Approximately equal to inductive reactance
- C. Low, as compared to the circuit resistance
- D. Approximately equal to capacitive reactance

E5A04 Answer: A. The magnitude of the impedance of a circuit with a resistor, an inductor and a capacitor all in parallel, at resonance is approximately equal to circuit resistance.

What is the magnitude of the current at the input of a series RLC circuit as the frequency goes through resonance?

- A. Minimum
- B. Maximum
- C. R/L
- D. L/R

E5A05 Answer: B. The magnitude of the current at the input of a series RLC circuit as the frequency goes through resonance is at maximum.

What is the magnitude of the circulating current within the components of a parallel LC circuit at resonance?

- A. It is at a minimum
- B. It is at a maximum
- C. It equals 1 divided by the quantity 2 times Pi, multiplied by the square root of inductance L multiplied by capacitance C
- D. It equals 2 multiplied by Pi, multiplied by frequency, multiplied by inductance

E5A06 Answer: B. The magnitude of the circulating current within the components of a parallel LC circuit at resonance is at a maximum.

What is the magnitude of the current at the input of a parallel RLC circuit at resonance?

- A. Minimum
- B. Maximum
- C. R/L
- D. L/R

E5A07 Answer: A. The magnitude of the current at the input of a parallel RLC circuit at resonance is at a minimum.

What is the phase relationship between the current through and the voltage across a series resonant circuit at resonance?

- A. The voltage leads the current by 90 degrees
- B. The current leads the voltage by 90 degrees
- C. The voltage and current are in phase
- D. The voltage and current are 180 degrees out of phase

E5A08 Answer: C. In a series resonant circuit at resonance, the voltage and current are in phase.

How is the Q of an RLC parallel resonant circuit calculated?

- A. Reactance of either the inductance or capacitance divided by the resistance
- B. Reactance of either the inductance or capacitance multiplied by the resistance
- C. Resistance divided by the reactance of either the inductance or capacitance
- D. Reactance of the inductance multiplied by the reactance of the capacitance

E5A09 Answer: C. The Q of an RLC parallel resonant circuit is calculated by dividing the resistance by the reactance of either the inductance or capacitance.

How is the Q of an RLC series resonant circuit calculated?

- A. Reactance of either the inductance or capacitance divided by the resistance
- B. Reactance of either the inductance or capacitance times the resistance
- C. Resistance divided by the reactance of either the inductance or capacitance
- D. Reactance of the inductance times the reactance of the capacitance

E5A10 Answer: A. The Q of an RLC series resonant circuit is calculated by dividing the reactance of either the inductance or capacitance by the resistance.

What is the half-power bandwidth of a parallel resonant circuit that has a resonant frequency of 7.1 MHz and a Q of 150?

- A. 157.8 Hz
- B. 315.6 Hz
- C. 47.3 kHz
- D. 23.67 kHz

E5A11 Answer: C. The half-power bandwidth of a parallel resonant circuit that has a resonant frequency of 7.1 MHz and a Q of 150 is 47.3 kHz.

What is the half-power bandwidth of a parallel resonant circuit that has a resonant frequency of 3.7 MHz and a Q of 118?

- A. 436.6 kHz
- B. 218.3 kHz
- C. 31.4 kHz
- D. 15.7 kHz

E5A12 Answer: C. The half-power bandwidth of a parallel resonant circuit that has a resonant frequency of 3.7 MHz and a Q of 118 is 31.4 kHz.

What is an effect of increasing Q in a resonant circuit?

- A. Fewer components are needed for the same performance
- B. Parasitic effects are minimized
- C. Internal voltages and circulating currents increase
- D. Phase shift can become uncontrolled

E5A13 Answer: Increasing Q in a resonant circuit can cause internal voltages and circulating currents to increase.

What is the resonant frequency of a series RLC circuit if R is 22 ohms, L is 50 microhenrys and C is 40 picofarads?

- A. 44.72 MHz
- B. 22.36 MHz
- C. 3.56 MHz
- D. 1.78 MHz

E5A14 Answer: C. The resonant frequency of a series RLC circuit if R is 22 ohms, L is 50 microhenrys and C is 40 picofarads is 3.56 MHz.

Which of the following can increase Q for inductors and capacitors?

- A. Lower losses
- B. Lower reactance
- C. Lower self-resonant frequency
- D. Higher self-resonant frequency

E5A15 Answer: A. Lower losses can increase Q for inductors and capacitors.

What is the resonant frequency of a parallel RLC circuit if R is 33 ohms, L is 50 microhenrys and C is 10 picofarads?

- A. 23.5 MHz
- B. 23.5 kHz
- C. 7.12 kHz
- D. 7.12 MHz

E5A16 Answer: D. The resonant frequency of a parallel RLC circuit with R = 33 ohms, L = 50 microhenrys and C = 10 picofarads, is 7.12 MHz.

What is the result of increasing the Q of an impedance-matching circuit?

- A. Matching bandwidth is decreased
- B. Matching bandwidth is increased
- C. Matching range is increased
- D. It has no effect on impedance matching

E5A17 Answer: A. Increasing the Q of an impedance-matching circuit will decrease the matching bandwidth.

E5B – Time constants and phase relationships: RLC time constants; definition; time constants in RL and RC circuits; phase angle between voltage and current; phase angles of series RLC; phase angle of inductance vs susceptance; admittance and susceptance

What is the term for the time required for the capacitor in an RC circuit to be charged to 63.2% of the applied voltage?

- A. An exponential rate of one
- B. One time constant
- C. One exponential period
- D. A time factor of one

E5B01 Answer: B. A time-constant is the time required for the capacitor in an RC circuit to be charged to 63.2% of the applied voltage.

What is the term for the time it takes for a charged capacitor in an RC circuit to discharge to 36.8% of its initial voltage?

- A. One discharge period
- B. An exponential discharge rate of one
- C. A discharge factor of one
- D. One time constant

E5B02 Answer: D. A time-constant is the time it takes for a charged capacitor in an RC circuit to discharge to 36.8% of its initial voltage.

What happens to the phase angle of a reactance when it is converted to a susceptance?

- A. It is unchanged
- B. The sign is reversed
- C. It is shifted by 90 degrees
- D. The susceptance phase angle is the inverse of the reactance phase angle

E5B03 Answer: B. The sign of a phase angle of a reactance is reversed when it is converted to a susceptance.

What is the time constant of a circuit having two 220 microfarad capacitors and two 1 megohm resistors, all in parallel?

- A. 55 seconds
- B. 110 seconds
- C. 440 seconds
- D. 220 seconds

E5B04 Answer: D. The time constant of a circuit having two 220 microfarad capacitors and two 1 megohm resistors, all in parallel, is 220 seconds.

What happens to the magnitude of a reactance when it is converted to a susceptance?

- A. It is unchanged
- B. The sign is reversed
- C. It is shifted by 90 degrees
- D. The magnitude of the susceptance is the reciprocal of the magnitude of the reactance

E5B05 Answer: D. When a reactance is converted to a susceptance, the magnitude of the susceptance is the reciprocal of the magnitude of the reactance.

What is susceptance?

- A. The magnetic impedance of a circuit
- B. The ratio of magnetic field to electric field
- C. The inverse of reactance
- D. A measure of the efficiency of a transformer

E5B06 Answer: C. Susceptance is the inverse of reactance.

What is the phase angle between the voltage across and the current through a series RLC circuit if X_C is 500 ohms, R is 1 kilohm, and X_L is 250 ohms?

- A. 68.2 degrees with the voltage leading the current
- B. 14.0 degrees with the voltage leading the current
- C. 14.0 degrees with the voltage lagging the current
- D. 68.2 degrees with the voltage lagging the current

E5B07 Answer: C. The phase angle of a series RLC circuit with $X_C = 500$ ohms, $R = 1$ kilohm, and $X_L = 250$ ohms is 14.0 degrees with the voltage lagging the current.

What is the phase angle between the voltage across and the current through a series RLC circuit if X_C is 100 ohms, R is 100 ohms, and X_L is 75 ohms?

- A. 14 degrees with the voltage lagging the current
- B. 14 degrees with the voltage leading the current
- C. 76 degrees with the voltage leading the current
- D. 76 degrees with the voltage lagging the current

E5B08 Answer: A. The phase angle of a series RLC circuit with $X_C = 100$ ohms, $R = 100$ ohms, and $X_L = 75$ ohms is 14 degrees with the voltage lagging the current.

What is the relationship between the current through a capacitor and the voltage across a capacitor?

- A. Voltage and current are in phase
- B. Voltage and current are 180 degrees out of phase
- C. Voltage leads current by 90 degrees
- D. Current leads voltage by 90 degrees

E5B09 Answer: D. In a capacitor, current leads voltage by 90 degrees.

What is the relationship between the current through an inductor and the voltage across an inductor?

- A. Voltage leads current by 90 degrees
- B. Current leads voltage by 90 degrees
- C. Voltage and current are 180 degrees out of phase
- D. Voltage and current are in phase

E5B10 Answer: A. In an inductor, voltage leads current by 90 degrees.

What is the phase angle between the voltage across and the current through a series RLC circuit if X_C is 25 ohms, R is 100 ohms, and X_L is 50 ohms?

- A. 14 degrees with the voltage lagging the current
- B. 14 degrees with the voltage leading the current
- C. 76 degrees with the voltage lagging the current
- D. 76 degrees with the voltage leading the current

E5B11 Answer: B. The phase angle of a series RLC circuit with $X_C = 25$ ohms, $R = 100$ ohms, and $X_L = 50$ ohms is 14 degrees with the voltage leading the current.

What is admittance?

- A. The inverse of impedance
- B. The term for the gain of a field effect transistor
- C. The turns ratio of a transformer
- D. The unit used for Q factor

E5B12 Answer: A. Admittance is the inverse of impedance.

What letter is commonly used to represent susceptance?

- A. G
- B. X
- C. Y
- D. B

E5B13 Answer: D. the letter 'B' is commonly used to represent susceptance.

E5C – Coordinate systems and phasors in electronics: Rectangular Coordinates; Polar Coordinates; Phasors

Which of the following represents a capacitive reactance in rectangular notation?

- A. $-jX$
- B. $+jX$
- C. X
- D. Omega

E5C01 Answer: A. " $-jX$ " represents a capacitive reactance in rectangular notation.

How are impedances described in polar coordinates?

- A. By X and R values
- B. By real and imaginary parts
- C. By phase angle and amplitude
- D. By Y and G values

E5C02 Answer: C. Impedances are described by phase angle and amplitude in polar coordinates.

Which of the following represents an inductive reactance in polar coordinates?

- A. A positive real part
- B. A negative real part
- C. A positive phase angle
- D. A negative phase angle

E5C03 Answer: C. A positive phase angle represents an inductive reactance in polar coordinates.

Which of the following represents a capacitive reactance in polar coordinates?

- A. A positive real part
- B. A negative real part
- C. A positive phase angle
- D. A negative phase angle

E5C04 Answer: D. A negative phase angle represents a capacitive reactance in polar coordinates.

What is the name of the diagram used to show the phase relationship between impedances at a given frequency?

- A. Venn diagram
- B. Near field diagram
- C. Phasor diagram
- D. Far field diagram

E5C05 Answer: C. A phasor diagram is used to show the phase relationship between impedances at a given frequency.

What does the impedance $50-j25$ represent?

- A. 50 ohms resistance in series with 25 ohms inductive reactance
- B. 50 ohms resistance in series with 25 ohms capacitive reactance
- C. 25 ohms resistance in series with 50 ohms inductive reactance
- D. 25 ohms resistance in series with 50 ohms capacitive reactance

E5C06 Answer: B. The impedance $50-j25$ represents 50 ohms resistance in series with 25 ohms capacitive reactance.

What is a vector?

- A. The value of a quantity that changes over time
- B. A quantity with both magnitude and an angular component
- C. The inverse of the tangent function
- D. The inverse of the sine function

E5C07 Answer: B. A vector is a quantity with both magnitude and an angular component.

What coordinate system is often used to display the phase angle of a circuit containing resistance, inductive and/or capacitive reactance?

- A. Maidenhead grid
- B. Faraday grid
- C. Elliptical coordinates
- D. Polar coordinates

E5C08 Answer: D. Polar coordinates are often used to display the phase angle of a circuit containing resistance, inductive and/or capacitive reactance.

When using rectangular coordinates to graph the impedance of a circuit, what does the horizontal axis represent?

- A. Resistive component
- B. Reactive component
- C. The sum of the reactive and resistive components
- D. The difference between the resistive and reactive components

E5C09 Answer: A. When using rectangular coordinates to graph the impedance of a circuit, the horizontal axis represents the resistive component.

When using rectangular coordinates to graph the impedance of a circuit, what does the vertical axis represent?

- A. Resistive component
- B. Reactive component
- C. The sum of the reactive and resistive components
- D. The difference between the resistive and reactive components

E5C10 Answer: B. When using rectangular coordinates to graph the impedance of a circuit, the vertical axis represents the reactive component.

What do the two numbers that are used to define a point on a graph using rectangular coordinates represent?

- A. The magnitude and phase of the point
- B. The sine and cosine values
- C. The coordinate values along the horizontal and vertical axes
- D. The tangent and cotangent values

E5C11 Answer: C. The two numbers that are used to define a point on a graph using rectangular coordinates represent the coordinate values along the horizontal and vertical axes.

If you plot the impedance of a circuit using the rectangular coordinate system and find the impedance point falls on the right side of the graph on the horizontal axis, what do you know about the circuit?

- A. It has to be a direct current circuit
- B. It contains resistance and capacitive reactance
- C. It contains resistance and inductive reactance
- D. It is equivalent to a pure resistance

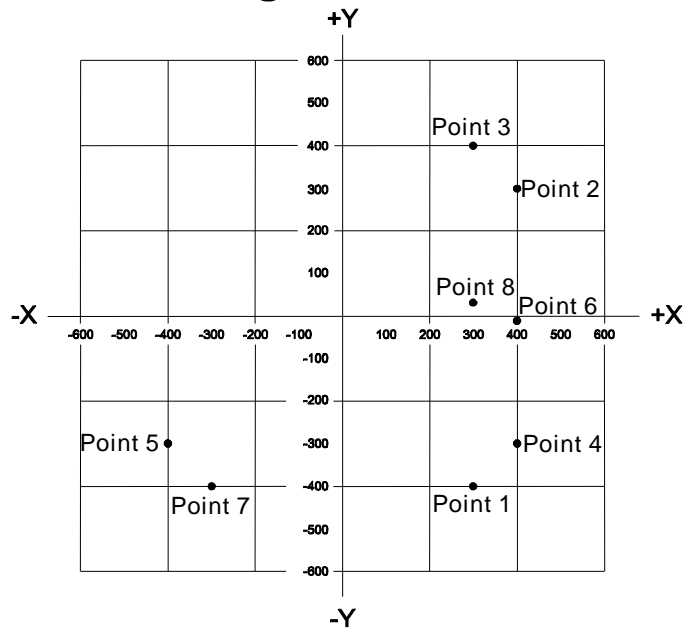
E5C12 Answer: D. If you plot the impedance of a circuit using the rectangular coordinate system and find the impedance point falls on the right side of the graph on the horizontal axis, you know the circuit is equivalent to a pure resistance.

What coordinate system is often used to display the resistive, inductive, and/or capacitive reactance components of impedance?

- A. Maidenhead grid
- B. Faraday grid
- C. Elliptical coordinates
- D. Rectangular coordinates

E5C13 Answer: D. Rectangular coordinates are used to display the resistive, inductive, and/or capacitive reactance components of impedance.

Figure E5-2



Which point on Figure E5-2 best represents the impedance of a series circuit consisting of a 400 ohm resistor and a 38 picofarad capacitor at 14 MHz?

- A. Point 2
- B. Point 4
- C. Point 5
- D. Point 6

E5C14 Answer: B. Point 4 on Figure E5-2 best represents the impedance of a series circuit consisting of a 400 ohm resistor and a 38 picofarad capacitor at 14 MHz.

Which point in Figure E5-2 best represents the impedance of a series circuit consisting of a 300 ohm resistor and an 18 microhenry inductor at 3.505 MHz?

- A. Point 1
- B. Point 3
- C. Point 7
- D. Point 8

E5C15 Answer: B. Point 3 on Figure E5-2 best represents the impedance of a series circuit consisting of a 300 ohm resistor and an 18 microhenry inductor at 3.505 MHz.

Which point on Figure E5-2 best represents the impedance of a series circuit consisting of a 300 ohm resistor and a 19 picofarad capacitor at 21.200 MHz?

- A. Point 1
- B. Point 3
- C. Point 7
- D. Point 8

E5C16 Answer: A. Point 1 on Figure E5-2 best represents the impedance of a series circuit consisting of a 300 ohm resistor and a 19 picofarad capacitor at 21.200 MHz.

Which point on Figure E5-2 best represents the impedance of a series circuit consisting of a 300 ohm resistor, a 0.64-microhenry inductor and an 85-picofarad capacitor at 24.900 MHz?

- A. Point 1
- B. Point 3
- C. Point 5
- D. Point 8

E5C17 Answer: D. Point 8 on Figure E5-2 best represents the impedance of a series circuit consisting of a 300 ohm resistor, a 0.64-microhenry inductor and an 85-picofarad capacitor at 24.900 MHz.

E5D – AC and RF energy in real circuits: skin effect; electrostatic and electromagnetic fields; reactive power; power factor; electrical length of conductors at UHF and microwave frequencies

What is the result of skin effect?

- A. As frequency increases, RF current flows in a thinner layer of the conductor, closer to the surface
- B. As frequency decreases, RF current flows in a thinner layer of the conductor, closer to the surface
- C. Thermal effects on the surface of the conductor increase the impedance
- D. Thermal effects on the surface of the conductor decrease the impedance

E5D01 Answer: A. As a result of skin effect, as frequency increases, RF current flows in a thinner layer of the conductor, closer to the surface.

Why is it important to keep lead lengths short for components used in circuits for VHF and above?

- A. To increase the thermal time constant
- B. To avoid unwanted inductive reactance
- C. To maintain component lifetime
- D. All of these choices are correct

E5D02 Answer: B. It is important to keep lead lengths short for components used in circuits for VHF and above to avoid unwanted inductive reactance.

What is microstrip?

- A. Lightweight transmission line made of common zip cord
- B. Miniature coax used for low power applications
- C. Short lengths of coax mounted on printed circuit boards to minimize time delay between microwave circuits
- D. Precision-printed circuit conductors above a ground plane that provide constant impedance interconnects at microwave frequencies

E5D03 Answer: D. Microstrip is precision-printed circuit conductors above a ground plane that provide constant impedance interconnects at microwave frequencies

Why are short connections necessary at microwave frequencies?

- A. To increase neutralizing resistance
- B. To reduce phase shift along the connection
- C. Because of ground reflections
- D. To reduce noise figure

E5D04 Answer: B. Short connections are necessary at microwave frequencies to reduce phase shift along the connection.

Which parasitic characteristic increases with conductor length?

- A. Inductance
- B. Permeability
- C. Permittivity
- D. Malleability

E5D05 Answer: A. Inductance increases with conductor length.

In what direction is the magnetic field oriented about a conductor in relation to the direction of electron flow?

- A. In the same direction as the current
- B. In a direction opposite to the current
- C. In all directions; omni-directional
- D. In a direction determined by the left-hand rule

E5D06 Answer: D. the magnetic field is oriented in a direction determined by the left-hand rule about a conductor in relation to the direction of electron flow.

What determines the strength of the magnetic field around a conductor?

- A. The resistance divided by the current
- B. The ratio of the current to the resistance
- C. The diameter of the conductor
- D. The amount of current flowing through the conductor

E5D07 Answer: D. The amount of current flowing through a conductor determines the strength of the magnetic field around it.

What type of energy is stored in an electromagnetic or electrostatic field?

- A. Electromechanical energy
- B. Potential energy
- C. Thermodynamic energy
- D. Kinetic energy

E5D08 Answer: B. Potential energy is stored in an electromagnetic or electrostatic field.

What happens to reactive power in an AC circuit that has both ideal inductors and ideal capacitors?

- A. It is dissipated as heat in the circuit
- B. It is repeatedly exchanged between the associated magnetic and electric fields, but is not dissipated
- C. It is dissipated as kinetic energy in the circuit
- D. It is dissipated in the formation of inductive and capacitive fields

E5D09 Answer: B. Reactive power in an AC circuit that has both ideal inductors and ideal capacitors is repeatedly exchanged between the associated magnetic and electric fields, but is not dissipated.

How can the true power be determined in an AC circuit where the voltage and current are out of phase?

- A. By multiplying the apparent power times the power factor
- B. By dividing the reactive power by the power factor
- C. By dividing the apparent power by the power factor
- D. By multiplying the reactive power times the power factor

E5D10 Answer: A. True power in an out-of-phase AC circuit can be determined by multiplying the apparent power times the power factor.

What is the power factor of an R-L circuit having a 60 degree phase angle between the voltage and the current?

- A. 1.414
- B. 0.866
- C. 0.5
- D. 1.73

E5D11 Answer: C. The power factor of an R-L circuit having a 60 degree phase angle between the voltage and the current is 0.5.

How many watts are consumed in a circuit having a power factor of 0.2 if the input is 100-VAC at 4 amperes?

- A. 400 watts
- B. 80 watts
- C. 2000 watts
- D. 50 watts

E5D12 Answer: B. 80 watts are consumed in a circuit having a power factor of 0.2 and an input of 100-VAC at 4 amperes.

How much power is consumed in a circuit consisting of a 100 ohm resistor in series with a 100 ohm inductive reactance drawing 1 ampere?

- A. 70.7 Watts
- B. 100 Watts
- C. 141.4 Watts
- D. 200 Watts

E5D13 Answer: B. 100 Watts are consumed in a circuit consisting of a 100 ohm resistor in series with a 100 ohm inductive reactance drawing 1 ampere.

What is reactive power?

- A. Wattless, nonproductive power
- B. Power consumed in wire resistance in an inductor
- C. Power lost because of capacitor leakage
- D. Power consumed in circuit Q

E5D14 Answer: A. Reactive power is wattless, nonproductive power.

What is the power factor of an R-L circuit having a 45 degree phase angle between the voltage and the current?

- A. 0.866
- B. 1.0
- C. 0.5
- D. 0.707

E5D15 Answer: D. The power factor of an R-L circuit having a 45 degree phase angle between the voltage and the current is 0.707.

What is the power factor of an R-L circuit having a 30 degree phase angle between the voltage and the current?

- A. 1.73
- B. 0.5
- C. 0.866
- D. 0.577

E5D16 Answer: C. The power factor of an R-L circuit having a 30 degree phase angle between the voltage and the current is 0.866.

How many watts are consumed in a circuit having a power factor of 0.6 if the input is 200VAC at 5 amperes?

- A. 200 watts
- B. 1000 watts
- C. 1600 watts
- D. 600 watts

E5D17 Answer: D. 600watts are consumed in a circuit having a power factor of 0.6 if the input is 200VAC at 5 amperes.

How many watts are consumed in a circuit having a power factor of 0.71 if the apparent power is 500VA?

- A. 704 W
- B. 355 W
- C. 252 W
- D. 1.42 mW

E5D18 Answer: B. 355 watts are consumed in a circuit having a power factor of 0.71 if the apparent power is 500VA.

E6 – Circuit Components

E6A – Semiconductor materials and devices: semiconductor materials; germanium, silicon, P-type, N-type; transistor types: NPN, PNP, junction, field-effect transistors: enhancement mode; depletion mode; MOS; CMOS; N-channel; P-channel

In what application is gallium arsenide used as a semiconductor material in preference to germanium or silicon?

- A. In high-current rectifier circuits
- B. In high-power audio circuits
- C. In microwave circuits
- D. In very low frequency RF circuits

E6A01 Answer: C. Gallium arsenide is used as a semiconductor material in preference to germanium or silicon in microwave circuits.

Which of the following semiconductor materials contains excess free electrons?

- A. N-type
- B. P-type
- C. Bipolar
- D. Insulated gate

E6A02 Answer: A. N-type semiconductor materials contain excess free electrons.

Why does a PN-junction diode not conduct current when reverse biased?

- A. Only P-type semiconductor material can conduct current
- B. Only N-type semiconductor material can conduct current
- C. Holes in P-type material and electrons in the N-type material are separated by the applied voltage, widening the depletion region
- D. Excess holes in P-type material combine with the electrons in N-type material, converting the entire diode into an insulator

E6A03 Answer: C. A PN-junction diode does not conduct current when reverse biased because holes in P-type material and electrons in the N-type material are separated by the applied voltage, widening the depletion region.

What is the name given to an impurity atom that adds holes to a semiconductor crystal structure?

- A. Insulator impurity
- B. N-type impurity
- C. Acceptor impurity
- D. Donor impurity

E6A04 Answer: C. Acceptor impurities are atoms that add holes to a semiconductor crystal structure.

What is the alpha of a bipolar junction transistor?

- A. The change of collector current with respect to base current
- B. The change of base current with respect to collector current
- C. The change of collector current with respect to emitter current
- D. The change of collector current with respect to gate current

E6A05 Answer: C. The alpha of a bipolar junction transistor is the change in collector current with respect to emitter current.

What is the beta of a bipolar junction transistor?

- A. The frequency at which the current gain is reduced to 1
- B. The change in collector current with respect to base current
- C. The breakdown voltage of the base to collector junction
- D. The switching speed of the transistor

E6A06 Answer: B. The beta of a bipolar junction transistor is the change in collector current with respect to the base current.

Which of the following indicates that a silicon NPN junction transistor is biased on?

- A. Base-to-emitter resistance of approximately 6 to 7 ohms
- B. Base-to-emitter resistance of approximately 0.6 to 0.7 ohms
- C. Base-to-emitter voltage of approximately 6 to 7 volts
- D. Base-to-emitter voltage of approximately 0.6 to 0.7 volts

E6A07 Answer: D. A base-to-emitter voltage of approximately 0.6 to 0.7 volts would indicate that a silicon NPN junction transistor is biased on.

What term indicates the frequency at which the grounded-base current gain of a transistor has decreased to 0.7 of the gain obtainable at 1 kHz?

- A. Corner frequency
- B. Alpha rejection frequency
- C. Beta cutoff frequency
- D. Alpha cutoff frequency

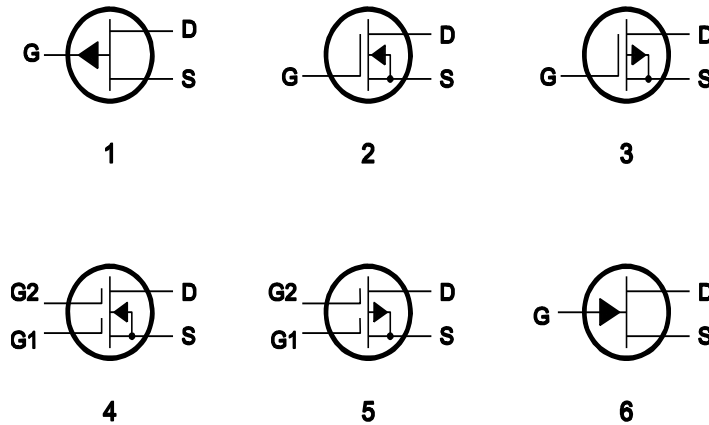
E6A08 Answer: D. Alpha cutoff frequency is the frequency at which the grounded-base current gain of a transistor has decreased to 0.7 of the gain obtainable at 1 kHz.

What is a depletion-mode FET?

- A. An FET that exhibits a current flow between source and drain when no gate voltage is applied
- B. An FET that has no current flow between source and drain when no gate voltage is applied
- C. Any FET without a channel
- D. Any FET for which holes are the majority carriers

E6A09 Answer: A. A depletion-mode FET is an FET that exhibits a current flow between source and drain when no gate voltage is applied.

Figure E6-2



In Figure E6-2, what is the schematic symbol for an N-channel dual-gate MOSFET?

- A. 2
- B. 4
- C. 5
- D. 6

E6A10 Answer: B. In Figure E6-2, the schematic symbol for an N-channel dual-gate MOSFET is 4.

In Figure E6-2, what is the schematic symbol for a P-channel junction FET?

- A. 1
- B. 2
- C. 3
- D. 6

E6A11 Answer: A. In Figure E6-2, the schematic symbol for a P-channel junction FET is 1.

Why do many MOSFET devices have internally connected Zener diodes on the gates?

- A. To provide a voltage reference for the correct amount of reverse-bias gate voltage
- B. To protect the substrate from excessive voltages
- C. To keep the gate voltage within specifications and prevent the device from overheating
- D. To reduce the chance of the gate insulation being punctured by static discharges or excessive voltages

E6A12 Answer: D. Many MOSFET devices have internally connected Zener diodes on the gates to reduce the chance of the gate insulation being punctured by static discharges or excessive voltages.

What do the initials CMOS stand for?

- A. Common Mode Oscillating System
- B. Complementary Mica-Oxide Silicon
- C. Complementary Metal-Oxide Semiconductor
- D. Common Mode Organic Silicon

E6A13 Answer: C. CMOS stands for Complementary Metal-Oxide Semiconductor.

How does DC input impedance at the gate of a field-effect transistor compare with the DC input impedance of a bipolar transistor?

- A. They are both low impedance
- B. An FET has low input impedance; a bipolar transistor has high input impedance
- C. An FET has high input impedance; a bipolar transistor has low input impedance
- D. They are both high impedance

E6A14 Answer: C. An FET has high input impedance; a bipolar transistor has low input impedance.

Which semiconductor material contains excess holes in the outer shell of electrons?

- A. N-type
- B. P-type
- C. Superconductor-type
- D. Bipolar-type

E6A15 Answer: B. P-type semiconductor materials contain excess holes in the outer shell of electrons.

What are the majority charge carriers in N-type semiconductor material?

- A. Holes
- B. Free electrons
- C. Free protons
- D. Free neutrons

E6A16 Answer: B. Free electrons are the majority charge carriers in N-type semiconductor material. In N-type semiconductor material, holes are the minority carriers.

What are the names of the three terminals of a field-effect transistor?

- A. Gate 1, gate 2, drain
- B. Emitter, base, collector
- C. Emitter, base 1, base 2
- D. Gate, drain, source

E6A17 Answer: D. The three terminals of a field-effect transistor are called the gate, drain, and source.

E6B - Diodes

What is the most useful characteristic of a Zener diode?

- A. A constant current drop under conditions of varying voltage
- B. A constant voltage drop under conditions of varying current
- C. A negative resistance region
- D. An internal capacitance that varies with the applied voltage

E6B01 Answer: B. Zener diodes are most useful because they have a constant voltage drop under conditions of varying current.

What is an important characteristic of a Schottky diode as compared to an ordinary silicon diode when used as a power supply rectifier?

- A. Much higher reverse voltage breakdown
- B. Controlled reverse avalanche voltage
- C. Enhanced carrier retention time
- D. Less forward voltage drop

E6B02 Answer: D. Schottky diodes can be more useful than ordinary diodes in some applications because they have less forward voltage drop.

What special type of diode is capable of both amplification and oscillation?

- A. Point contact
- B. Zener
- C. Tunnel
- D. Junction

E6B03 Answer: C. Tunnel diodes are capable of both amplification and oscillation.

What type of semiconductor device is designed for use as a voltage-controlled capacitor?

- A. Varactor diode
- B. Tunnel diode
- C. Silicon-controlled rectifier
- D. Zener diode

E6B04 Answer: A. Varactor diode are designed for use as voltage-controlled capacitors.

What characteristic of a PIN diode makes it useful as an RF switch or attenuator?

- A. Extremely high reverse breakdown voltage
- B. Ability to dissipate large amounts of power
- C. Reverse bias controls its forward voltage drop
- D. A large region of intrinsic material

E6B05 Answer: D. The large region of intrinsic material in a PIN diode makes it useful as an RF switch or attenuator.

Which of the following is a common use of a hot-carrier diode?

- A. As balanced mixers in FM generation
- B. As a variable capacitance in an automatic frequency control circuit
- C. As a constant voltage reference in a power supply
- D. As a VHF/UHF mixer or detector

E6B06 Answer: D. Hot-carrier diodes are often used as VHF/UHF mixers or detectors.

What is the failure mechanism when a junction diode fails due to excessive current?

- A. Excessive inverse voltage
- B. Excessive junction temperature
- C. Insufficient forward voltage
- D. Charge carrier depletion

E6B07 Answer: B. When a junction diode fails due to excessive current, it is called an excessive junction temperature failure.

Which of the following describes a type of semiconductor diode?

- A. Metal-semiconductor junction
- B. Electrolytic rectifier
- C. CMOS-field effect
- D. Thermionic emission diode

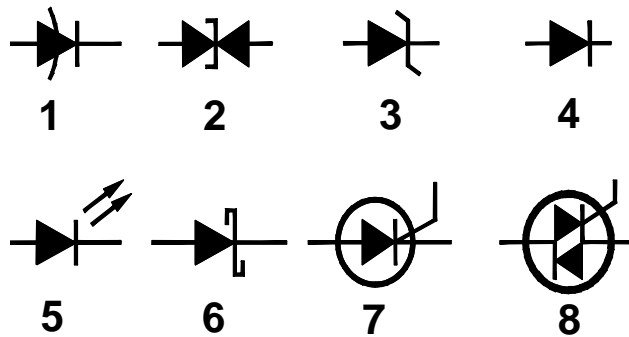
E6B08 Answer: A. Metal-semiconductor junctions are used to make Schottky diodes.

What is a common use for point contact diodes?

- A. As a constant current source
- B. As a constant voltage source
- C. As an RF detector
- D. As a high voltage rectifier

E6B09 Answer: C. Point contact diodes are used as RF detectors.

Figure E6-3



In Figure E6-3, what is the schematic symbol for a light-emitting diode?

- A. 1
- B. 5
- C. 6
- D. 7

E6B10 Answer: B. In Figure E6-3, the schematic symbol for a light-emitting diode is 5.

What is used to control the attenuation of RF signals by a PIN diode?

- A. Forward DC bias current
- B. A sub-harmonic pump signal
- C. Reverse voltage larger than the RF signal
- D. Capacitance of an RF coupling capacitor

E6B11 Answer: A. Forward DC bias current is used to control the attenuation of RF signals by a PIN diode.

What is one common use for PIN diodes?

- A. As a constant current source
- B. As a constant voltage source
- C. As an RF switch
- D. As a high voltage rectifier

E6B12 Answer: C. PIN diodes are commonly used as RF switches.

What type of bias is required for an LED to emit light?

- A. Reverse bias
- B. Forward bias
- C. Zero bias
- D. Inductive bias

E6B13 Answer: B. Forward bias is required for an LED to emit light.

E6C – Digital ICs: Families of digital ICs; gates; Programmable Logic Devices (PLDs)

What is the function of hysteresis in a comparator?

- A. To prevent input noise from causing unstable output signals
- B. To allow the comparator to be used with AC input signal
- C. To cause the output to change states continually
- D. To increase the sensitivity

E6C01 Answer: A. Hysteresis in a comparator prevents input noise from causing unstable output signals.

What happens when the level of a comparator's input signal crosses the threshold?

- A. The IC input can be damaged
- B. The comparator changes its output state
- C. The comparator enters latch-up
- D. The feedback loop becomes unstable

E6C02 Answer: B. When the level of a comparator's input signal crosses the threshold, the comparator changes its output state.

What is tri-state logic?

- A. Logic devices with 0, 1, and high impedance output states
- B. Logic devices that utilize ternary math
- C. Low power logic devices designed to operate at 3 volts
- D. Proprietary logic devices manufactured by Tri-State Devices

E6C03 Answer: A. Tri-state logic devices have 0, 1, and high impedance output states.

What is the primary advantage of tri-state logic?

- A. Low power consumption
- B. Ability to connect many device outputs to a common bus
- C. High speed operation
- D. More efficient arithmetic operations

E6C04 Answer: B. The primary advantage of tri-state logic is the ability to connect many device outputs to a common bus.

What is an advantage of CMOS logic devices over TTL devices?

- A. Differential output capability
- B. Lower distortion
- C. Immune to damage from static discharge
- D. Lower power consumption

E6C05 Answer: D. An advantage of CMOS logic devices over TTL devices is lower power consumption.

Why do CMOS digital integrated circuits have high immunity to noise on the input signal or power supply?

- A. Larger bypass capacitors are used in CMOS circuit design
- B. The input switching threshold is about two times the power supply voltage
- C. The input switching threshold is about one-half the power supply voltage
- D. Input signals are stronger

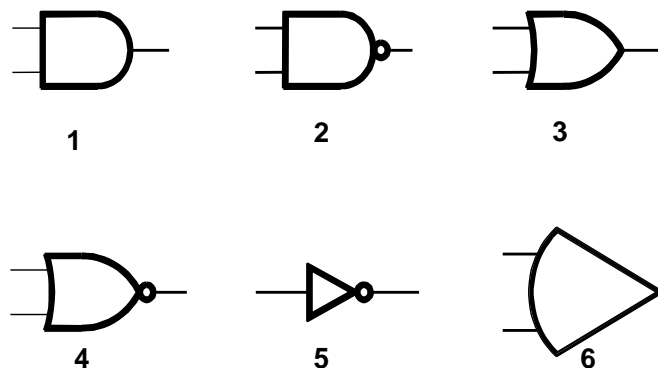
E6C06 Answer: C. CMOS digital integrated circuits have high immunity to noise on the input signal because the input switching threshold is about one-half the power supply voltage.

What best describes a pull-up or pull-down resistor?

- A. A resistor in a keying circuit used to reduce key clicks
- B. A resistor connected to the positive or negative supply line used to establish a voltage when an input or output is an open circuit
- C. A resistor that insures that an oscillator frequency does not drive lower over time
- D. A resistor connected to an op-amp output that only functions when the logic output is false

E6C07 Answer: B. Pull-up or pull-down resistors are connected to the positive or negative supply line and used to establish a voltage when an input or output is an open circuit.

Figure E6-5



In Figure E6-5, what is the schematic symbol for a NAND gate?

- A. 1
- B. 2
- C. 3
- D. 4

E6C08 Answer: B. In Figure E6-5, the schematic symbol for a NAND gate is 2.

What is a Programmable Logic Device (PLD)?

- A. A device to control industrial equipment
- B. A programmable collection of logic gates and circuits in a single integrated circuit
- C. Programmable equipment used for testing digital logic integrated circuits
- D. An algorithm for simulating logic functions during circuit design

E6C09 Answer: B. A PLD is a programmable collection of logic gates and circuits in a single integrated circuit.

In Figure E6-5, what is the schematic symbol for a NOR gate?

- A. 1
- B. 2
- C. 3
- D. 4

E6C10 Answer: D. In Figure E6-5, the schematic symbol for a NOR gate is 4.

In Figure E6-5, what is the schematic symbol for the NOT operation (inverter)?

- A. 2
- B. 4
- C. 5
- D. 6

E6C11 Answer: C. In Figure E6-5, the schematic symbol for the NOT operation is 5.

What is BiCMOS logic?

- A. A logic device with two CMOS circuits per package
- B. A FET logic family based on bimetallic semiconductors
- C. A logic family based on bismuth CMOS devices
- D. An integrated circuit logic family using both bipolar and CMOS transistors

E6C12 Answer: D. BiCMOS logic is an integrated circuit logic family using both bipolar and CMOS transistors.

Which of the following is an advantage of BiCMOS logic?

- A. Its simplicity results in much less expensive devices than standard CMOS
- B. It is totally immune to electrostatic damage
- C. It has the high input impedance of CMOS and the low output impedance of bipolar transistors
- D. All of these choices are correct

E6C13 Answer: C. BiCMOS logic has the advantage of high input impedance and low output impedance.

What is the primary advantage of using a Programmable Gate Array (PGA) in a logic circuit?

- A. Many similar gates are less expensive than a mixture of gate types
- B. Complex logic functions can be created in a single integrated circuit
- C. A PGA contains its own internal power supply
- D. All of these choices are correct

E6C14 Answer: B. The primary advantage of using a Programmable Gate Array (PGA) in a logic circuit is that complex logic functions can be created in a single integrated circuit.

E6D – Toroidal and Solenoidal Inductors: permeability, core material, selecting, winding; transformers; Piezoelectric devices

How many turns will be required to produce a 5-microhenry inductor using a powdered-iron toroidal core that has an inductance index (A L) value of 40 microhenrys/100 turns?

- A. 35 turns
- B. 13 turns
- C. 79 turns
- D. 141 turns

E6D01 Answer: A. 35 turns will be required to produce a 5-microhenry inductor using a powdered-iron toroidal core that has an inductance index (A L) value of 40 microhenrys/100 turns.

What is the equivalent circuit of a quartz crystal?

- A. Motional capacitance, motional inductance, and loss resistance in series, all in parallel with a shunt capacitor representing electrode and stray capacitance
- B. Motional capacitance, motional inductance, loss resistance, and a capacitor representing electrode and stray capacitance all in parallel
- C. Motional capacitance, motional inductance, loss resistance, and a capacitor representing electrode and stray capacitance all in series
- D. Motional inductance and loss resistance in series, paralleled with motional capacitance and a capacitor representing electrode and stray capacitance

E6D02 Answer: A. The equivalent circuit of a quartz crystal is motional capacitance, motional inductance, and loss resistance in series, all in parallel with a shunt capacitor representing electrode and stray capacitance.

Which of the following is an aspect of the piezoelectric effect?

- A. Mechanical deformation of material by the application of a voltage
- B. Mechanical deformation of material by the application of a magnetic field
- C. Generation of electrical energy in the presence of light
- D. Increased conductivity in the presence of light

E6D03 Answer: A. The piezoelectric effect is mechanical deformation of material by the application of a voltage.

Which materials are commonly used as a slug core in a variable inductor?

- A. Polystyrene and polyethylene
- B. Ferrite and brass
- C. Teflon and Delrin
- D. Cobalt and aluminum

E6D04 Answer: B. Ferrite and brass are commonly used as slug cores in variable inductors.

What is one reason for using ferrite cores rather than powdered-iron in an inductor?

- A. Ferrite toroids generally have lower initial permeability
- B. Ferrite toroids generally have better temperature stability
- C. Ferrite toroids generally require fewer turns to produce a given inductance value
- D. Ferrite toroids are easier to use with surface mount technology

E6D05 Answer: C. Ferrite toroids generally require fewer turns than powdered-iron to produce a given inductance value.

What core material property determines the inductance of a toroidal inductor?

- A. Thermal impedance
- B. Resistance
- C. Reactivity
- D. Permeability

E6D06 Answer: D. Permeability of the core material determines the inductance of a toroidal inductor.

What is the usable frequency range of inductors that use toroidal cores, assuming a correct selection of core material for the frequency being used?

- A. From a few kHz to no more than 30 MHz
- B. From less than 20 Hz to approximately 300 MHz
- C. From approximately 10 Hz to no more than 3000 kHz
- D. From about 100 kHz to at least 1000 GHz

E6D07 Answer: B. Inductors that use toroidal cores range from less than 20 Hz to approximately 300 MHz.

What is one reason for using powdered-iron cores rather than ferrite cores in an inductor?

- A. Powdered-iron cores generally have greater initial permeability
- B. Powdered-iron cores generally maintain their characteristics at higher currents
- C. Powdered-iron cores generally require fewer turns to produce a given inductance
- D. Powdered-iron cores use smaller diameter wire for the same inductance

E6D08 Answer: B. Powdered-iron cores generally maintain their characteristics at higher currents than ferrite cores.

What devices are commonly used as VHF and UHF parasitic suppressors at the input and output terminals of a transistor HF amplifier?

- A. Electrolytic capacitors
- B. Butterworth filters
- C. Ferrite beads
- D. Steel-core toroids

E6D09 Answer: C. Ferrite beads are commonly used as VHF and UHF parasitic suppressors at the input and output terminals of transistor HF amplifiers.

What is a primary advantage of using a toroidal core instead of a solenoidal core in an inductor?

- A. Toroidal cores confine most of the magnetic field within the core material
- B. Toroidal cores make it easier to couple the magnetic energy into other components
- C. Toroidal cores exhibit greater hysteresis
- D. Toroidal cores have lower Q characteristics

E6D10 Answer: A. Toroidal cores confine most of the magnetic field within the core material, while solenoidal cores do not.

How many turns will be required to produce a 1-mH inductor using a core that has an inductance index (A L) value of 523 millihenrys/1000 turns?

- A. 2 turns
- B. 4 turns
- C. 43 turns
- D. 229 turns

E6D11 Answer: C. 43 turns will be required to produce a 1-mH inductor using a core that has an inductance index (A L) value of 523 millihenrys/1000 turns.

What is the definition of saturation in a ferrite core inductor?

- A. The inductor windings are over coupled
- B. The inductor's voltage rating is exceeded causing a flashover
- C. The ability of the inductor's core to store magnetic energy has been exceeded
- D. Adjacent inductors become over-coupled

E6D12 Answer: C. Saturation in a ferrite core inductor is when the ability of the inductor's core to store magnetic energy has been exceeded.

What is the primary cause of inductor self-resonance?

- A. Inter-turn capacitance
- B. The skin effect
- C. Inductive kickback
- D. Non-linear core hysteresis

E6D13 Answer: A. Inter-turn capacitance is the primary cause of inductor self-resonance.

Which type of slug material decreases inductance when inserted into a coil?

- A. Ceramic
- B. Brass
- C. Ferrite
- D. Powdered-iron

E6D14 Answer: B. Brass slug material decreases inductance when inserted into a coil.

What is current in the primary winding of a transformer called if no load is attached to the secondary?

- A. Magnetizing current
- B. Direct current
- C. Excitation current
- D. Stabilizing current

E6D15 Answer: A. Current in the primary winding of a transformer is called magnetizing current when no load is attached to the secondary.

What is the common name for a capacitor connected across a transformer secondary that is used to absorb transient voltage spikes?

- A. Clipper capacitor
- B. Trimmer capacitor
- C. Feedback capacitor
- D. Snubber capacitor

E6D16 Answer: D. A capacitor connected across a transformer secondary that is used to absorb transient voltage spikes is called a snubber capacitor.

Why should core saturation of a conventional impedance matching transformer be avoided?

- A. Harmonics and distortion could result
- B. Magnetic flux would increase with frequency
- C. RF susceptance would increase
- D. Temporary changes of the core permeability could result

E6D17 Answer: A. Core saturation of a conventional impedance matching transformer should be avoided because harmonics and distortion could result.

E6E – Analog ICs: MMICs, CCDs, Device packages

Which of the following is true of a charge-coupled device (CCD)?

- A. Its phase shift changes rapidly with frequency
- B. It is a CMOS analog-to-digital converter
- C. It samples an analog signal and passes it in stages from the input to the output
- D. It is used in a battery charger circuit

E6E01 Answer: C. A charge-coupled device (CCD) samples an analog signal and passes it in stages from the input to the output.

Which of the following device packages is a through-hole type?

- A. DIP
- B. PLCC
- C. Ball grid array
- D. SOT

E6E02 Answer: A. DIP is a type of through-hole device packaging.

Which of the following materials is likely to provide the highest frequency of operation when used in MMICs?

- A. Silicon
- B. Silicon nitride
- C. Silicon dioxide
- D. Gallium nitride

E6E03 Answer: D. Gallium nitride is likely to provide the highest frequency of operation when used in MMICs.

Which is the most common input and output impedance of circuits that use MMICs?

- A. 50 ohms
- B. 300 ohms
- C. 450 ohms
- D. 10 ohms

E6E04 Answer: A. 50 ohms is the most common input and output impedance of circuits that use MMICs.

Which of the following noise figure values is typical of a low-noise UHF preamplifier?

- A. 2 dB
- B. -10 dB
- C. 44 dBm
- D. -20 dBm

E6E05 Answer: A. 2 dB is a typical noise value of a low-noise UHF preamplifier.

What characteristics of the MMIC make it a popular choice for VHF through microwave circuits?

- A. The ability to retrieve information from a single signal even in the presence of other strong signals
- B. Plate current that is controlled by a control grid
- C. Nearly infinite gain, very high input impedance, and very low output impedance
- D. Controlled gain, low noise figure, and constant input and output impedance over the specified frequency range

E6E06 Answer: D. MMICs have controlled gain, low noise figures, and constant input and output impedances over the specified frequency range, making them popular for VHF through microwave circuits.

Which of the following is typically used to construct a MMIC-based microwave amplifier?

- A. Ground-plane construction
- B. Microstrip construction
- C. Point-to-point construction
- D. Wave-soldering construction

E6E07 Answer: B. Microstrip construction is typically used to construct a MMIC-based microwave amplifier.

How is voltage from a power supply normally furnished to the most common type of monolithic microwave integrated circuit (MMIC)?

- A. Through a resistor and/or RF choke connected to the amplifier output lead
- B. MMICs require no operating bias
- C. Through a capacitor and RF choke connected to the amplifier input lead
- D. Directly to the bias voltage (VCC IN) lead

E6E08 Answer: A. Power supplies are normally connected to MMICs through a resistor and/or RF choke connected to the amplifier output lead.

Which of the following component package types would be most suitable for use at frequencies above the HF range?

- A. TO-220
- B. Axial lead
- C. Radial lead
- D. Surface mount

E6E09 Answer: D. Components in surface mount packaging are most suitable for use at frequencies above the HF range.

What is the packaging technique in which leadless components are soldered directly to circuit boards?

- A. Direct soldering
- B. Virtual lead mounting
- C. Stripped lead
- D. Surface mount

E6E10 Answer: D. Surface mount is the packaging technique in which leadless components are soldered directly to circuit boards.

What is a characteristic of DIP packaging used for integrated circuits?

- A. Package mounts in a direct inverted position
- B. Low leakage doubly insulated package
- C. Two chips in each package (Dual In Package)
- D. A total of two rows of connecting pins placed on opposite sides of the package (Dual In-line Package)

E6E11 Answer: DIP packaging for ICs is a total of two rows of connecting pins placed on opposite sides of the package.

Why are high-power RF amplifier ICs and transistors sometimes mounted in ceramic packages?

- A. High-voltage insulating ability
- B. Better dissipation of heat
- C. Enhanced sensitivity to light
- D. To provide a low-pass frequency response

E6E12 Answer: B. High-power RF amplifier ICs and transistors sometimes mounted in ceramic packages for better dissipation of heat.

E6F – Optical components: photoconductive principles and effects, photovoltaic systems, optical couplers, optical sensors, and optoisolators; LCDs

What is photoconductivity?

- A. The conversion of photon energy to electromotive energy
- B. The increased conductivity of an illuminated semiconductor
- C. The conversion of electromotive energy to photon energy
- D. The decreased conductivity of an illuminated semiconductor

E6F01 Answer: B. Photoconductivity is the increased conductivity of an illuminated semiconductor.

What happens to the conductivity of a photoconductive material when light shines on it?

- A. It increases
- B. It decreases
- C. It stays the same
- D. It becomes unstable

E6F02 Answer: A. Photoconductive material becomes more conductive when light shines on it.

What is the most common configuration of an optoisolator or optocoupler?

- A. A lens and a photomultiplier
- B. A frequency modulated helium-neon laser
- C. An amplitude modulated helium-neon laser
- D. An LED and a phototransistor

E6F03 Answer: D. Optoisolators and optocouplers are most often used as LEDs and phototransistors, respectively.

What is the photovoltaic effect?

- A. The conversion of voltage to current when exposed to light
- B. The conversion of light to electrical energy
- C. The conversion of electrical energy to mechanical energy
- D. The tendency of a battery to discharge when used outside

E6F04 Answer: B. The photovoltaic effect is the conversion of light to electrical energy.

Which describes an optical shaft encoder?

- A. A device which detects rotation of a control by interrupting a light source with a patterned wheel
- B. A device which measures the strength of a beam of light using analog to digital conversion
- C. A digital encryption device often used to encrypt spacecraft control signals
- D. A device for generating RTTY signals by means of a rotating light source

E6F05 Answer: A. An optical shaft encoder is a device which detects rotation of a control by interrupting a light source with a patterned wheel.

Which of these materials is affected the most by photoconductivity?

- A. A crystalline semiconductor
- B. An ordinary metal
- C. A heavy metal
- D. A liquid semiconductor

E6F06 Answer: A. Crystalline semiconductors are most affected by photoconductivity.

What is a solid state relay?

- A. A relay using transistors to drive the relay coil
- B. A device that uses semiconductors to implement the functions of an electromechanical relay
- C. A mechanical relay that latches in the on or off state each time it is pulsed
- D. A passive delay line

E6F07 Answer: B. A solid state relay is a device that uses semiconductors to implement the functions of an electromechanical relay.

Why are optoisolators often used in conjunction with solid state circuits when switching 120VAC?

- A. Optoisolators provide a low impedance link between a control circuit and a power circuit
- B. Optoisolators provide impedance matching between the control circuit and power circuit
- C. Optoisolators provide a very high degree of electrical isolation between a control circuit and the circuit being switched
- D. Optoisolators eliminate the effects of reflected light in the control circuit

E6F08 Answer: C. Optoisolators are often used in conjunction with solid state circuits when switching 120VAC because they provide a very high degree of electrical isolation between a control circuit and the circuit being switched.

What is the efficiency of a photovoltaic cell?

- A. The output RF power divided by the input DC power
- B. The effective payback period
- C. The open-circuit voltage divided by the short-circuit current under full illumination
- D. The relative fraction of light that is converted to current

E6F09 Answer: D. The efficiency of a photovoltaic cell is the relative fraction of light that is converted to current.

What is the most common type of photovoltaic cell used for electrical power generation?

- A. Selenium
- B. Silicon
- C. Cadmium Sulfide
- D. Copper oxide

E6F10 Answer: B. The most common type of photovoltaic cell used for electrical power generation is silicon.

What is the approximate open-circuit voltage produced by a fully-illuminated silicon photovoltaic cell?

- A. 0.1 V
- B. 0.5 V
- C. 1.5 V
- D. 12 V

E6F11 Answer: B. The approximate open-circuit voltage produced by a fully-illuminated silicon photovoltaic cell is 0.5 V.

What absorbs the energy from light falling on a photovoltaic cell?

- A. Protons
- B. Photons
- C. Electrons
- D. Holes

E6F12 Answer: C. Electrons absorb the energy from light falling on photovoltaic cells.

What is a liquid crystal display (LCD)?

- A. A modern replacement for a quartz crystal oscillator which displays its fundamental frequency
- B. A display utilizing a crystalline liquid and polarizing filters which becomes opaque when voltage is applied
- C. A frequency-determining unit for a transmitter or receiver
- D. A display that uses a glowing liquid to remain brightly lit in dim light

E6F13 Answer: B. A liquid crystal display is a display utilizing a crystalline liquid and polarizing filters which become opaque when voltage is applied.

Which of the following is true of LCD displays?

- A. They are hard to view in high ambient light conditions
- B. They may be hard to view through polarized lenses
- C. They only display alphanumeric symbols
- D. All of these choices are correct

E6F14 Answer: B. LCD displays may be hard to view through polarized lenses.

E7 – Practical Circuits

E7A – Digital circuits: digital circuit principles and logic circuits: classes of logic elements; positive and negative logic; frequency dividers; truth tables

Which is a bi-stable circuit?

- A. An "AND" gate
- B. An "OR" gate
- C. A flip-flop
- D. A clock

E7A01 Answer: C. Flip-flops are bi-stable circuits.

What is the function of a decade counter digital IC?

- A. It produces one output pulse for every ten input pulses
- B. It decodes a decimal number for display on a seven segment LED display
- C. It produces ten output pulses for every input pulse
- D. It adds two decimal numbers together

E7A02 Answer: A. Decade counters produce one output pulse for every ten input pulses.

Which of the following can divide the frequency of a pulse train by 2?

- A. An XOR gate
- B. A flip-flop
- C. An OR gate
- D. A multiplexer

E7A03 Answer: B. Flip-flops can divide the frequency of a pulse train by 2.

How many flip-flops are required to divide a signal frequency by 4?

- A. 1
- B. 2
- C. 4
- D. 8

E7A04 Answer: B. Two flip-flops are required to divide a signal frequency by 4.

Which of the following is a circuit that continuously alternates between two states without an external clock?

- A. Monostable multivibrator
- B. J-K flip-flop
- C. T flip-flop
- D. Astable multivibrator

E7A05 Answer: D. Astable multivibrators continuously alternate between two states without an external clock.

What is a characteristic of a monostable multivibrator?

- A. It switches momentarily to the opposite binary state and then returns to its original state after a set time
- B. It produces a continuous square wave oscillating between 1 and 0
- C. It stores one bit of data in either a 0 or 1 state
- D. It maintains a constant output voltage, regardless of variations in the input voltage

E7A06 Answer: A. monostable multivibrators switch momentarily to the opposite binary state and then return to their original state after a set time.

What logical operation does a NAND gate perform?

- A. It produces logic "0" at its output only when all inputs are logic "0"
- B. It produces logic "1" at its output only when all inputs are logic "1"
- C. It produces logic "0" at its output if some but not all inputs are logic "1"
- D. It produces logic "0" at its output only when all inputs are logic "1"

E7A07 Answer: D. NAND gates produce a logic "0" at their output only when all inputs are logic "1".

What logical operation does an OR gate perform?

- A. It produces logic "1" at its output if any or all inputs are logic "1"
- B. It produces logic "0" at its output if all inputs are logic "1"
- C. It only produces logic "0" at its output when all inputs are logic "1"
- D. It produces logic "1" at its output if all inputs are logic "0"

E7A08 Answer: A. OR gates produce logic "1" at their output if any or all inputs are logic "1".

What logical operation is performed by an exclusive NOR gate?

- A. It produces logic "0" at its output only if all inputs are logic "0"
- B. It produces logic "1" at its output only if all inputs are logic "1"
- C. It produces logic "0" at its output if any single input is logic "1"
- D. It produces logic "1" at its output if any single input is logic "1"

E7A09 Answer: C. Exclusive NOR gates produce logic "0" at their output if any single input is logic "1".

What is a truth table?

- A. A table of logic symbols that indicate the high logic states of an op-amp
- B. A diagram showing logic states when the digital device output is true
- C. A list of inputs and corresponding outputs for a digital device
- D. A table of logic symbols that indicate the logic states of an op-amp

E7A10 Answer: C. A truth table is a list of inputs and corresponding outputs for a digital device.

What type of logic defines "1" as a high voltage?

- A. Reverse Logic
- B. Assertive Logic
- C. Negative Logic
- D. Positive Logic

E7A11 Answer: D. Positive Logic defines "1" as a high voltage.

What type of logic defines "0" as a high voltage?

- A. Reverse Logic
- B. Assertive Logic
- C. Negative Logic
- D. Positive Logic

E7A12 Answer: C. Negative Logic defines "0" as a high voltage.

E7B – Amplifiers: Class of operation; vacuum tube and solid-state circuits; distortion and intermodulation; spurious and parasitic suppression; microwave amplifiers; switching-type amplifiers

For what portion of a signal cycle does a Class AB amplifier operate?

- A. More than 180 degrees but less than 360 degrees
- B. Exactly 180 degrees
- C. The entire cycle
- D. Less than 180 degrees

E7B01 Answer: A. A class AB amplifier operates on more than 180 degrees but less than 360 degrees of a signal cycle.

What is a Class D amplifier?

- A. A type of amplifier that uses switching technology to achieve high efficiency
- B. A low power amplifier that uses a differential amplifier for improved linearity
- C. An amplifier that uses drift-mode FETs for high efficiency
- D. A frequency doubling amplifier

E7B02 Answer: A. A class D amplifier uses switching technology to achieve high efficiency.

Which of the following components form the output of a class D amplifier circuit?

- A. A low-pass filter to remove switching signal components
- B. A high-pass filter to compensate for low gain at low frequencies
- C. A matched load resistor to prevent damage by switching transients
- D. A temperature compensating load resistor to improve linearity

E7B03 Answer: A. A low-pass filter to removes switching signal components from the output of a class D amplifier.

Where on the load line of a Class A common emitter amplifier would bias normally be set?

- A. Approximately half-way between saturation and cutoff
- B. Where the load line intersects the voltage axis
- C. At a point where the bias resistor equals the load resistor
- D. At a point where the load line intersects the zero bias current curve

E7B04 Answer: A. Bias would normally be set approximately half-way between saturation and cutoff for a class A common emitter amplifier.

What can be done to prevent unwanted oscillations in an RF power amplifier?

- A. Tune the stage for maximum SWR
- B. Tune both the input and output for maximum power
- C. Install parasitic suppressors and/or neutralize the stage
- D. Use a phase inverter in the output filter

E7B05 Answer: C. Installing parasitic suppressors and/or neutralizing the stage can prevent unwanted oscillations in an RF power amplifier.

Which of the following amplifier types reduces or eliminates even order harmonics?

- A. Push-push
- B. Push-pull
- C. Class C
- D. Class AB

E7B06 Answer: B. Push-pull amplifiers reduce or eliminate even order harmonics.

Which of the following is a likely result when a Class C amplifier is used to amplify a single-sideband phone signal?

- A. Reduced intermodulation products
- B. Increased overall intelligibility
- C. Signal inversion
- D. Signal distortion and excessive bandwidth

E7B07 Answer: D. Signal distortion and excessive bandwidth can result from a class C amplifier being used to amplify a single-sideband phone signal.

How can an RF power amplifier be neutralized?

- A. By increasing the driving power
- B. By reducing the driving power
- C. By feeding a 180-degree out-of-phase portion of the output back to the input
- D. By feeding an in-phase component of the output back to the input

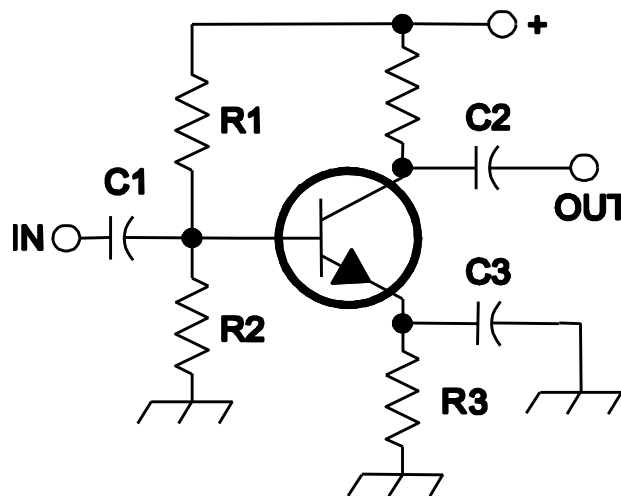
E7B08 Answer: C. An RF power amplifier can be neutralized by feeding a 180-degree out-of-phase portion of the output back to the input.

Which of the following describes how the loading and tuning capacitors are to be adjusted when tuning a vacuum tube RF power amplifier that employs a Pi-network output circuit?

- A. The loading capacitor is set to maximum capacitance and the tuning capacitor is adjusted for minimum allowable plate current
- B. The tuning capacitor is set to maximum capacitance and the loading capacitor is adjusted for minimum plate permissible current
- C. The loading capacitor is adjusted to minimum plate current while alternately adjusting the tuning capacitor for maximum allowable plate current
- D. The tuning capacitor is adjusted for minimum plate current, and the loading capacitor is adjusted for maximum permissible plate current

E7B09 Answer: D. When tuning a vacuum tube RF power amplifier that employs a Pi-network output circuit, the tuning capacitor is adjusted for minimum plate current, and the loading capacitor is adjusted for maximum permissible plate current.

Figure E7-1



In Figure E7-1, what is the purpose of R1 and R2?

- A. Load resistors
- B. Fixed bias
- C. Self bias
- D. Feedback

E7B10 Answer: B. In Figure E7-1, R1 and R2 are used as a fixed bias.

In Figure E7-1, what is the purpose of R3?

- A. Fixed bias
- B. Emitter bypass
- C. Output load resistor
- D. Self bias

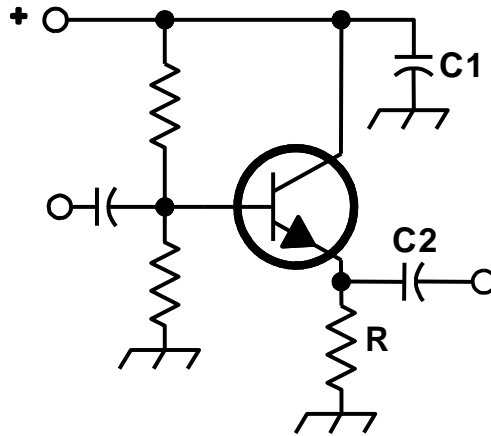
E7B11 Answer: D. In Figure E7-1, R3 is a self-bias.

What type of amplifier circuit is shown in Figure E7-1?

- A. Common base
- B. Common collector
- C. Common emitter
- D. Emitter follower

E7B12 Answer: C. A common emitter amplifier is shown in Figure E7-1.

Figure E7-2



In Figure E7-2, what is the purpose of R?

- A. Emitter load
- B. Fixed bias
- C. Collector load
- D. Voltage regulation

E7B13 Answer: A. In Figure E7-2, R is an emitter load.

Why are switching amplifiers more efficient than linear amplifiers?

- A. Switching amplifiers operate at higher voltages
- B. The power transistor is at saturation or cut-off most of the time, resulting in low power dissipation
- C. Linear amplifiers have high gain resulting in higher harmonic content
- D. Switching amplifiers use push-pull circuits

E7B14 Answer: B. Switching amplifiers are more efficient than linear amplifiers because the power transistor is at saturation or cut-off most of the time, resulting in low power dissipation.

What is one way to prevent thermal runaway in a bipolar transistor amplifier?

- A. Neutralization
- B. Select transistors with high beta
- C. Use a resistor in series with the emitter
- D. All of these choices are correct

E7B15 Answer: C. Using a resistor in series with the emitter is one way to prevent thermal runaway in a bipolar transistor amplifier

What is the effect of intermodulation products in a linear power amplifier?

- A. Transmission of spurious signals
- B. Creation of parasitic oscillations
- C. Low efficiency
- D. All of these choices are correct

E7B16 Answer: A. Intermodulation products result in transmission of spurious signals in a linear power amplifier.

Why are odd-order rather than even-order intermodulation distortion products of concern in linear power amplifiers?

- A. Because they are relatively close in frequency to the desired signal
- B. Because they are relatively far in frequency from the desired signal
- C. Because they invert the sidebands causing distortion
- D. Because they maintain the sidebands, thus causing multiple duplicate signals

E7B17 Answer: A. Odd-order intermodulation distortion products are of concern in linear power amplifiers because they are relatively close in frequency to the desired signal.

What is a characteristic of a grounded-grid amplifier?

- A. High power gain
- B. High filament voltage
- C. Low input impedance
- D. Low bandwidth

E7B18 Answer: C. Grounded-grid amplifiers have low input impedance.

E7C – Filters and matching networks: types of networks; types of filters; filter applications; filter characteristics; impedance matching; DSP filtering

How are the capacitors and inductors of a low-pass filter Pi-network arranged between the network's input and output?

- A. Two inductors are in series between the input and output, and a capacitor is connected between the two inductors and ground
- B. Two capacitors are in series between the input and output, and an inductor is connected between the two capacitors and ground
- C. An inductor is connected between the input and ground, another inductor is connected between the output and ground, and a capacitor is connected between the input and output
- D. A capacitor is connected between the input and ground, another capacitor is connected between the output and ground, and an inductor is connected between input and output

E7C01 Answer: D. In a low-pass filter Pi-network, a capacitor is connected between the input and ground, another capacitor is connected between the output and ground, and an inductor is connected between input and output.

Which of the following is a property of a T-network with series capacitors and a parallel shunt inductor?

- A. It is a low-pass filter
- B. It is a band-pass filter
- C. It is a high-pass filter
- D. It is a notch filter

E7C02 Answer: C. A T-network with series capacitors and a parallel shunt inductor is a high-pass filter.

What advantage does a Pi-L-network have over a regular Pi-network for impedance matching between the final amplifier of a vacuum-tube transmitter and an antenna?

- A. Greater harmonic suppression
- B. Higher efficiency
- C. Lower losses
- D. Greater transformation range

E7C03 Answer: A. A Pi-L-network has greater harmonic suppression than a regular Pi-network for impedance matching between the final amplifier of a vacuum-tube transmitter and an antenna.

How does an impedance-matching circuit transform a complex impedance to a resistive impedance?

- A. It introduces negative resistance to cancel the resistive part of impedance
- B. It introduces transconductance to cancel the reactive part of impedance
- C. It cancels the reactive part of the impedance and changes the resistive part to a desired value
- D. Network resistances are substituted for load resistances and reactances are matched to the resistances

E7C04 Answer: C. An impedance-matching circuit cancels the reactive part of the impedance and changes the resistive part to a desired value.

Which filter type is described as having ripple in the passband and a sharp cutoff?

- A. A Butterworth filter
- B. An active LC filter
- C. A passive op-amp filter
- D. A Chebyshev filter

E7C05 Answer: A Chebyshev filter is described as having ripple in the passband and a sharp cutoff.

What are the distinguishing features of an elliptical filter?

- A. Gradual passband rolloff with minimal stop band ripple
- B. Extremely flat response over its pass band with gradually rounded stop band corners
- C. Extremely sharp cutoff with one or more notches in the stop band
- D. Gradual passband rolloff with extreme stop band ripple

E7C06 Answer: C. An elliptical filter has an extremely sharp cutoff with one or more notches in the stop band.

What kind of filter would you use to attenuate an interfering carrier signal while receiving an SSB transmission?

- A. A band-pass filter
- B. A notch filter
- C. A Pi-network filter
- D. An all-pass filter

E7C07 Answer: B. A notch filter could be used to attenuate an interfering carrier signal while receiving an SSB transmission.

Which of the following factors has the greatest effect in helping determine the bandwidth and response shape of a crystal ladder filter?

- A. The relative frequencies of the individual crystals
- B. The DC voltage applied to the quartz crystal
- C. The gain of the RF stage preceding the filter
- D. The amplitude of the signals passing through the filter

E7C08 Answer: A. The relative frequencies of the individual crystals have the greatest effect in helping determine the bandwidth and response shape of a crystal ladder filter.

What is a Jones filter as used as part of an HF receiver IF stage?

- A. An automatic notch filter
- B. A variable bandwidth crystal lattice filter
- C. A special filter that emphasizes image responses
- D. A filter that removes impulse noise

E7C09 Answer: B. A Jones filter as used as part of an HF receiver IF stage is a variable bandwidth crystal lattice filter.

Which of the following filters would be the best choice for use in a 2 meter repeater duplexer?

- A. A crystal filter
- B. A cavity filter
- C. A DSP filter
- D. An L-C filter

E7C10 Answer: B. A cavity filter would be the best choice for use in a 2 meter repeater duplexer.

Which of the following is the common name for a filter network which is equivalent to two L-networks connected back-to-back with the two inductors in series and the capacitors in shunt at the input and output?

- A. Pi-L
- B. Cascode
- C. Omega
- D. Pi

E7C11 Answer: D. A Pi-network is equivalent to two L-networks connected back-to-back with the two inductors in series and the capacitors in shunt at the input and output.

Which describes a Pi-L-network used for matching a vacuum tube final amplifier to a 50 ohm unbalanced output?

- A. A Phase Inverter Load network
- B. A Pi-network with an additional series inductor on the output
- C. A network with only three discrete parts
- D. A matching network in which all components are isolated from ground

E7C12 Answer: B. A Pi-network with an additional series inductor on the output could be used to match a vacuum tube final amplifier to a 50 ohm unbalanced output.

What is one advantage of a Pi-matching network over an L-matching network consisting of a single inductor and a single capacitor?

- A. The Q of Pi-networks can be varied depending on the component values chosen
- B. L-networks cannot perform impedance transformation
- C. Pi-networks have fewer components
- D. Pi-networks are designed for balanced input and output

E7C13 Answer: A. An advantage of a Pi-matching network over an L-matching network consisting of a single inductor and a single capacitor is that the Q of Pi-networks can be varied depending on the component values chosen.

Which mode is most affected by non-linear phase response in a receiver IF filter?

- A. Meteor scatter
- B. Single-Sideband voice
- C. Digital
- D. Video

E7C14 Answer: C. Digital mode is most affected by non-linear phase response in a receiver IF filter.

What is a crystal lattice filter?

- A. A power supply filter made with interlaced quartz crystals
- B. An audio filter made with four quartz crystals that resonate at 1kHz intervals
- C. A filter with wide bandwidth and shallow skirts made using quartz crystals
- D. A filter with narrow bandwidth and steep skirts made using quartz crystals

E7C15 Answer: D. A crystal lattice filter is a filter with narrow bandwidth and steep skirts made using quartz crystals.

E7D – Power supplies and voltage regulators; Solar array charge controllers

What is one characteristic of a linear electronic voltage regulator?

- A. It has a ramp voltage as its output
- B. It eliminates the need for a pass transistor
- C. The control element duty cycle is proportional to the line or load conditions
- D. The conduction of a control element is varied to maintain a constant output voltage

E7D01 Answer: D. A linear electronic voltage regulator varies the conduction of a control element to maintain a constant output voltage.

What is one characteristic of a switching electronic voltage regulator?

- A. The resistance of a control element is varied in direct proportion to the line voltage or load current
- B. It is generally less efficient than a linear regulator
- C. The controlled device's duty cycle is changed to produce a constant average output voltage
- D. It gives a ramp voltage at its output

E7D02 Answer: C. A switching electronic voltage regulator changes the duty cycle of the controlled device to produce a constant average output voltage.

What device is typically used as a stable reference voltage in a linear voltage regulator?

- A. A Zener diode
- B. A tunnel diode
- C. An SCR
- D. A varactor diode

E7D03 Answer: A. A Zener diode is typically used as a stable reference voltage in a linear voltage regulator.

Which of the following types of linear voltage regulator usually make the most efficient use of the primary power source?

- A. A series current source
- B. A series regulator
- C. A shunt regulator
- D. A shunt current source

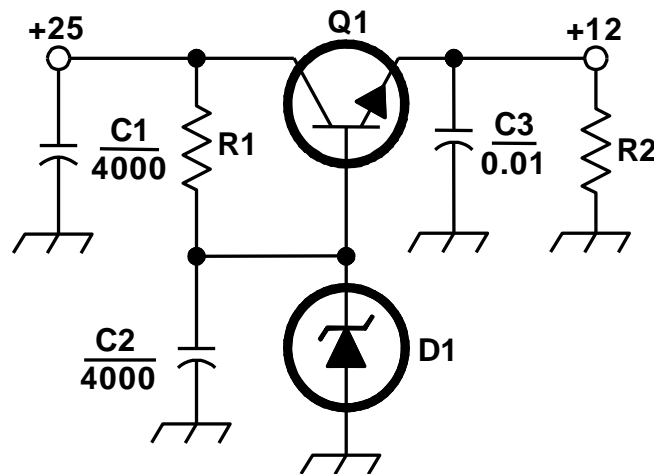
E7D04 Answer: B. A series linear voltage regulator usually makes the most efficient use of the primary power source.

Which of the following types of linear voltage regulator places a constant load on the unregulated voltage source?

- A. A constant current source
- B. A series regulator
- C. A shunt current source
- D. A shunt regulator

E7D05 Answer: D. A shunt regulator places a constant load on the unregulated voltage source.

Figure E7- 3



What is the purpose of Q1 in the circuit shown in Figure E7-3?

- A. It provides negative feedback to improve regulation
- B. It provides a constant load for the voltage source
- C. It increases the current-handling capability of the regulator
- D. It provides D1 with current

E7D06 Answer: C. The purpose of Q1 in the circuit shown in Figure E7-3 is increasing the current-handling capability of the regulator.

What is the purpose of C2 in the circuit shown in Figure E7-3?

- A. It bypasses hum around D1
- B. It is a brute force filter for the output
- C. To self-resonate at the hum frequency
- D. To provide fixed DC bias for Q1

E7D07 Answer: A. The purpose of C2 in the circuit shown in Figure E7-3 is bypassing hum around D1.

What type of circuit is shown in Figure E7-3?

- A. Switching voltage regulator
- B. Grounded emitter amplifier
- C. Linear voltage regulator
- D. Emitter follower

E7D08 Answer: C. A linear voltage regulator is shown in Figure E7-3.

What is the main reason to use a charge controller with a solar power system?

- A. Prevention of battery undercharge
- B. Control of electrolyte levels during battery discharge
- C. Prevention of battery damage due to overcharge
- D. Matching of day and night charge rates

E7D09 Answer: C. The main reason to use a charge controller with a solar power system is to prevent battery damage due to overcharging.

What is the primary reason that a high-frequency switching type high voltage power supply can be both less expensive and lighter in weight than a conventional power supply?

- A. The inverter design does not require any output filtering
- B. It uses a diode bridge rectifier for increased output
- C. The high frequency inverter design uses much smaller transformers and filter components for an equivalent power output
- D. It uses a large power factor compensation capacitor to create free power from the unused portion of the AC cycle

E7D10 Answer: C. The primary reason that a high-frequency switching type high voltage power supply can be both less expensive and lighter in weight than a conventional power supply is that the high frequency inverter design uses much smaller transformers and filter components for an equivalent power output.

What circuit element is controlled by a series analog voltage regulator to maintain a constant output voltage?

- A. Reference voltage
- B. Switching inductance
- C. Error amplifier
- D. Pass transistor

E7D11 Answer: D. A pass transistor is controlled by a series analog voltage regulator to maintain a constant output voltage.

What is the drop-out voltage of an analog voltage regulator?

- A. Minimum input voltage for rated power dissipation
- B. Maximum amount that the output voltage drops when the input voltage is varied over its specified range
- C. Minimum input-to-output voltage required to maintain regulation
- D. Maximum amount that the output voltage may decrease at rated load

E7D12 Answer: C. The drop-out voltage of an analog voltage regulator is the minimum input-to-output voltage required to maintain regulation.

What is the equation for calculating power dissipation by a series connected linear voltage regulator?

- A. Input voltage multiplied by input current
- B. Input voltage divided by output current
- C. Voltage difference from input to output multiplied by output current
- D. Output voltage multiplied by output current

E7D13 Answer: C. The equation for calculating power dissipation by a series connected linear voltage regulator is voltage difference from input to output multiplied by output current.

What is one purpose of a "bleeder" resistor in a conventional unregulated power supply?

- A. To cut down on waste heat generated by the power supply
- B. To balance the low-voltage filament windings
- C. To improve output voltage regulation
- D. To boost the amount of output current

E7D14 Answer: C. A "bleeder" resistor in a conventional unregulated power supply serves to improve output voltage regulation.

What is the purpose of a "step-start" circuit in a high voltage power supply?

- A. To provide a dual-voltage output for reduced power applications
- B. To compensate for variations of the incoming line voltage
- C. To allow for remote control of the power supply
- D. To allow the filter capacitors to charge gradually

E7D15 Answer: D. A "step-start" circuit in a high voltage power supply serves to allow the filter capacitors to charge gradually.

When several electrolytic filter capacitors are connected in series to increase the operating voltage of a power supply filter circuit, why should resistors be connected across each capacitor?

- A. To equalize, as much as possible, the voltage drop across each capacitor
- B. To provide a safety bleeder to discharge the capacitors when the supply is off
- C. To provide a minimum load current to reduce voltage excursions at light loads
- D. All of these choices are correct

E7D16 Answer: D. When several electrolytic filter capacitors are connected in series in a power supply filter circuit, resistors connected across each capacitor help to equalize the voltage drop across each capacitor, provide a safety bleeder to discharge the capacitors when the supply is off, and provide a minimum load current to reduce voltage excursions at light loads.

E7E – Modulation and demodulation: reactance, phase and balanced modulators; detectors; mixer stages

Which of the following can be used to generate FM phone emissions?

- A. A balanced modulator on the audio amplifier
- B. A reactance modulator on the oscillator
- C. A reactance modulator on the final amplifier
- D. A balanced modulator on the oscillator

E7E01 Answer: B. A reactance modulator on the oscillator can be used to generate FM phone emissions.

What is the function of a reactance modulator?

- A. To produce PM signals by using an electrically variable resistance
- B. To produce AM signals by using an electrically variable inductance or capacitance
- C. To produce AM signals by using an electrically variable resistance
- D. To produce PM signals by using an electrically variable inductance or capacitance

E7E02 Answer: D. A reactance modulator produces PM signals by using an electrically variable inductance or capacitance.

How does an analog phase modulator function?

- A. By varying the tuning of a microphone preamplifier to produce PM signals
- B. By varying the tuning of an amplifier tank circuit to produce AM signals
- C. By varying the tuning of an amplifier tank circuit to produce PM signals
- D. By varying the tuning of a microphone preamplifier to produce AM signals

E7E03 Answer: C. An analog phase modulator functions by varying the tuning of an amplifier tank circuit to produce PM signals.

What is one way a single-sideband phone signal can be generated?

- A. By using a balanced modulator followed by a filter
- B. By using a reactance modulator followed by a mixer
- C. By using a loop modulator followed by a mixer
- D. By driving a product detector with a DSB signal

E7E04 Answer: A. A single-sideband phone signal can be generated by using a balanced modulator followed by a filter.

What circuit is added to an FM transmitter to boost the higher audio frequencies?

- A. A de-emphasis network
- B. A heterodyne suppressor
- C. An audio prescaler
- D. A pre-emphasis network

E7E05 Answer: D. A pre-emphasis network can be added to an FM transmitter to boost the higher audio frequencies.

Why is de-emphasis commonly used in FM communications receivers?

- A. For compatibility with transmitters using phase modulation
- B. To reduce impulse noise reception
- C. For higher efficiency
- D. To remove third-order distortion products

E7E06 Answer: A. De-emphasis is commonly used in FM communications receivers for compatibility with transmitters using phase modulation.

What is meant by the term baseband in radio communications?

- A. The lowest frequency band that the transmitter or receiver covers
- B. The frequency components present in the modulating signal
- C. The unmodulated bandwidth of the transmitted signal
- D. The basic oscillator frequency in an FM transmitter that is multiplied to increase the deviation and carrier frequency

E7E07 Answer: B. Baseband is the frequency components present in the modulating signal.

What are the principal frequencies that appear at the output of a mixer circuit?

- A. Two and four times the original frequency
- B. The sum, difference and square root of the input frequencies
- C. The two input frequencies along with their sum and difference frequencies
- D. 1.414 and 0.707 times the input frequency

E7E08 Answer: C. The principal frequencies that appear at the output of a mixer circuit are the two input frequencies along with their sum and difference frequencies.

What occurs when an excessive amount of signal energy reaches a mixer circuit?

- A. Spurious mixer products are generated
- B. Mixer blanking occurs
- C. Automatic limiting occurs
- D. A beat frequency is generated

E7E09 Answer: A. When an excessive amount of signal energy reaches a mixer circuit, spurious mixer products are generated.

How does a diode detector function?

- A. By rectification and filtering of RF signals
- B. By breakdown of the Zener voltage
- C. By mixing signals with noise in the transition region of the diode
- D. By sensing the change of reactance in the diode with respect to frequency

E7E10 Answer: A. A diode detector functions by rectifying and filtering of RF signals.

Which type of detector is used for demodulating SSB signals?

- A. Discriminator
- B. Phase detector
- C. Product detector
- D. Phase comparator

E7E11 Answer: C. A product detector is used for demodulating SSB signals.

What is a frequency discriminator stage in a FM receiver?

- A. An FM generator circuit
- B. A circuit for filtering two closely adjacent signals
- C. An automatic band-switching circuit
- D. A circuit for detecting FM signals

E7E12 Answer: D. A frequency discriminator stage in a FM receiver is a circuit for detecting FM signals.

E7F – DSP filtering and other operations; Software Defined Radio Fundamentals; DSP modulation and demodulation

What is meant by direct digital conversion as applied to software defined radios?

- A. Software is converted from source code to object code during operation of the receiver
- B. Incoming RF is converted to a control voltage for a voltage controlled oscillator
- C. Incoming RF is digitized by an analog-to-digital converter without being mixed with a local oscillator signal
- D. A switching mixer is used to generate I and Q signals directly from the RF input

E7F01 Answer: Direct digital conversion is when incoming RF is digitized by an analog-to-digital converter without being mixed with a local oscillator signal.

What kind of digital signal processing audio filter is used to remove unwanted noise from a received SSB signal?

- A. An adaptive filter
- B. A crystal-lattice filter
- C. A Hilbert-transform filter
- D. A phase-inverting filter

E7F02 Answer: A. An adaptive filter is used to remove unwanted noise from a received SSB signal.

What type of digital signal processing filter is used to generate an SSB signal?

- A. An adaptive filter
- B. A notch filter
- C. A Hilbert-transform filter
- D. An elliptical filter

E7F03 Answer: A Hilbert-transform filter is used to generate an SSB signal.

What is a common method of generating an SSB signal using digital signal processing?

- A. Mixing products are converted to voltages and subtracted by adder circuits
- B. A frequency synthesizer removes the unwanted sidebands
- C. Emulation of quartz crystal filter characteristics
- D. Combine signals with a quadrature phase relationship

E7F04 Answer: D. Combining signals with a quadrature phase relationship is a common method of generating an SSB signal.

How frequently must an analog signal be sampled by an analog-to-digital converter so that the signal can be accurately reproduced?

- A. At half the rate of the highest frequency component of the signal
- B. At twice the rate of the highest frequency component of the signal
- C. At the same rate as the highest frequency component of the signal
- D. At four times the rate of the highest frequency component of the signal

E7F05 Answer: B. An analog signal be sampled at twice the rate of the highest frequency component of the signal by an analog-to-digital converter.

What is the minimum number of bits required for an analog-to-digital converter to sample a signal with a range of 1 volt at a resolution of 1 millivolt?

- A. 4 bits
- B. 6 bits
- C. 8 bits
- D. 10 bits

E7F06 Answer: D. The minimum number of bits required for an analog-to-digital converter to sample a signal with a range of 1 volt at a resolution of 1 millivolt is 10.

What function can a Fast Fourier Transform perform?

- A. Converting analog signals to digital form
- B. Converting digital signals to analog form
- C. Converting digital signals from the time domain to the frequency domain
- D. Converting 8-bit data to 16 bit data

E7F07 Answer: C. A Fast Fourier Transform can convert digital signals from the time domain to the frequency domain.

What is the function of decimation with regard to digital filters?

- A. Converting data to binary code decimal form
- B. Reducing the effective sample rate by removing samples
- C. Attenuating the signal
- D. Removing unnecessary significant digits

E7F08 Answer: B. Decimation is reducing the effective sample rate by removing samples.

Why is an anti-aliasing digital filter required in a digital decimator?

- A. It removes high-frequency signal components which would otherwise be reproduced as lower frequency components
- B. It peaks the response of the decimator, improving bandwidth
- C. It removes low frequency signal components to eliminate the need for DC restoration
- D. It notches out the sampling frequency to avoid sampling errors

E7F09 Answer: A. An anti-aliasing digital filter is required in a digital decimator to remove high-frequency signal components which would otherwise be reproduced as lower frequency components.

What aspect of receiver analog-to-digital conversion determines the maximum receive bandwidth of a Direct Digital Conversion SDR?

- A. Sample rate
- B. Sample width in bits
- C. Sample clock phase noise
- D. Processor latency

E7F10 Answer: A. Sample rate determines the maximum receive bandwidth of a Direct Digital Conversion SDR.

What sets the minimum detectable signal level for an SDR in the absence of atmospheric or thermal noise?

- A. Sample clock phase noise
- B. Reference voltage level and sample width in bits
- C. Data storage transfer rate
- D. Missing codes and jitter

E7F11 Answer: B. Reference voltage level and sample width in bits sets the minimum detectable signal level for an SDR in the absence of atmospheric or thermal noise.

What digital process is applied to I and Q signals in order to recover the baseband modulation information?

- A. Fast Fourier Transform
- B. Decimation
- C. Signal conditioning
- D. Quadrature mixing

E7F12 Answer: A. Fast Fourier Transforms are performed on I and Q signals in order to recover the baseband modulation information.

What is the function of taps in a digital signal processing filter?

- A. To reduce excess signal pressure levels
- B. Provide access for debugging software
- C. Select the point at which baseband signals are generated
- D. Provide incremental signal delays for filter algorithms

E7F13 Answer: D. Taps in a digital signal processing filter provide incremental signal delays for filter algorithms.

Which of the following would allow a digital signal processing filter to create a sharper filter response?

- A. Higher data rate
- B. More taps
- C. Complex phasor representations
- D. Double-precision math routines

E7F14 Answer: B. Having more taps would allow a digital signal processing filter to create a sharper filter response.

Which of the following is an advantage of a Finite Impulse Response (FIR) filter vs an Infinite Impulse Response (IIR) digital filter?

- A. FIR filters delay all frequency components of the signal by the same amount
- B. FIR filters are easier to implement for a given set of passband rolloff requirements
- C. FIR filters can respond faster to impulses
- D. All of these choices are correct

E7F15 Answer: A. FIR filters delay all frequency components of the signal by the same amount, as opposed to IIR filters.

How might the sampling rate of an existing digital signal be adjusted by a factor of $3/4$?

- A. Change the gain by a factor of $3/4$
- B. Multiply each sample value by a factor of $3/4$
- C. Add 3 to each input value and subtract 4 from each output value
- D. Interpolate by a factor of three, then decimate by a factor of four

E7F16 Answer: D. The sampling rate of an existing digital signal could be adjusted by a factor of $3/4$ by interpolating by a factor of three, then decimating by a factor of four.

What do the letters I and Q in I/Q Modulation represent?

- A. Inactive and Quiescent
- B. Instantaneous and Quasi-stable
- C. Instantaneous and Quenched
- D. In-phase and Quadrature

E7F17 Answer: D. The letters I and Q in I/Q Modulation represent In-phase and Quadrature.

E7G – Active filters and op-amp circuits: active audio filters; characteristics; basic circuit design; operational amplifiers

What is the typical output impedance of an integrated circuit op-amp?

- A. Very low
- B. Very high
- C. 100 ohms
- D. 1000 ohms

E7G01 Answer: A. The typical output impedance of an integrated circuit op-amp is very low.

What is the effect of ringing in a filter?

- A. An echo caused by a long time delay
- B. A reduction in high frequency response
- C. Partial cancellation of the signal over a range of frequencies
- D. Undesired oscillations added to the desired signal

E7G02 Answer: D. The effect of ringing in a filter is undesired oscillations added to the desired signal.

What is the typical input impedance of an integrated circuit op-amp?

- A. 100 ohms
- B. 1000 ohms
- C. Very low
- D. Very high

E7G03 Answer: D. The typical input impedance of an integrated circuit op-amp is very high.

What is meant by the term op-amp input offset voltage?

- A. The output voltage of the op-amp minus its input voltage
- B. The difference between the output voltage of the op-amp and the input voltage required in the immediately following stage
- C. The differential input voltage needed to bring the open loop output voltage to zero
- D. The potential between the amplifier input terminals of the op-amp in an open loop condition

E7G04 Answer: C. Op-amp input offset voltage is the differential input voltage needed to bring the open loop output voltage to zero.

How can unwanted ringing and audio instability be prevented in a multi-section op-amp RC audio filter circuit?

- A. Restrict both gain and Q
- B. Restrict gain but increase Q
- C. Restrict Q but increase gain
- D. Increase both gain and Q

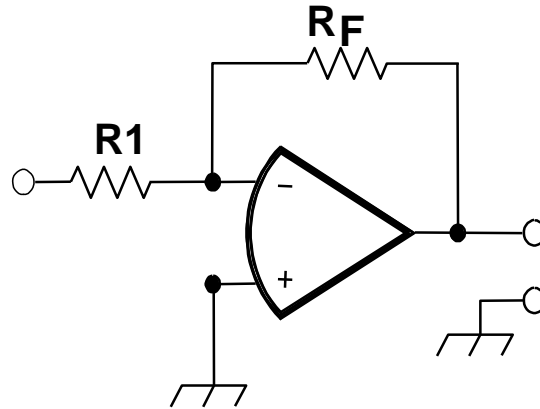
E7G05 Answer: A. Ringing and audio instability be prevented in a multi-section op-amp RC audio filter circuit by restricting both gain and Q.

Which of the following is the most appropriate use of an op-amp active filter?

- A. As a high-pass filter used to block RFI at the input to receivers
- B. As a low-pass filter used between a transmitter and a transmission line
- C. For smoothing power supply output
- D. As an audio filter in a receiver

E7G06 Answer: D. The most appropriate use of an op-amp active filter is as an audio filter in a receiver.

Figure E7-4



What magnitude of voltage gain can be expected from the circuit in Figure E7-4 when R_1 is 10 ohms and R_F is 470 ohms?

- A. 0.21
- B. 94
- C. 47
- D. 24

E7G07 Answer: C. The voltage gain from the circuit in Figure E7-4 when R_1 is 10 ohms and R_F is 470 ohms should be 47.

How does the gain of an ideal operational amplifier vary with frequency?

- A. It increases linearly with increasing frequency
- B. It decreases linearly with increasing frequency
- C. It decreases logarithmically with increasing frequency
- D. It does not vary with frequency

E7G08 Answer: D. The gain of an ideal operational amplifier does not vary with frequency.

What will be the output voltage of the circuit shown in Figure E7-4 if R_1 is 1000 ohms, R_F is 10,000 ohms, and 0.23 volts DC is applied to the input?

- A. 0.23 volts
- B. 2.3 volts
- C. -0.23 volts
- D. -2.3 volts

E7G09 Answer: D. The output voltage of the circuit shown in Figure E7-4 when R_1 is 1000 ohms, R_F is 10,000 ohms, and 0.23 volts DC is applied to the input is -2.3 volts.

What absolute voltage gain can be expected from the circuit in Figure E7-4 when R1 is 1800 ohms and RF is 68 kilohms?

- A. 1
- B. 0.03
- C. 38
- D. 76

E7G10 Answer: C. A voltage gain of 38 can be expected from the circuit in Figure E7-4 when R1 is 1800 ohms and RF is 68 kilohms.

What absolute voltage gain can be expected from the circuit in Figure E7-4 when R1 is 3300 ohms and RF is 47 kilohms?

- A. 28
- B. 14
- C. 7
- D. 0.07

E7G11 Answer: B. An absolute voltage gain of 14 can be expected from the circuit in Figure E7-4 when R1 is 3300 ohms and RF is 47 kilohms.

What is an integrated circuit operational amplifier?

- A. A high-gain, direct-coupled differential amplifier with very high input impedance and very low output impedance
- B. A digital audio amplifier whose characteristics are determined by components external to the amplifier
- C. An amplifier used to increase the average output of frequency modulated amateur signals to the legal limit
- D. A RF amplifier used in the UHF and microwave regions

E7G12 Answer: A. An integrated circuit operational amplifier is a high-gain, direct-coupled differential amplifier with very high input impedance and very low output impedance.

E7H – Oscillators and signal sources: types of oscillators; synthesizers and phase-locked loops; direct digital synthesizers; stabilizing thermal drift; microphonics; high accuracy oscillators

What are three oscillator circuits used in Amateur Radio equipment?

- A. Taft, Pierce and negative feedback
- B. Pierce, Fenner and Beane
- C. Taft, Hartley and Pierce
- D. Colpitts, Hartley and Pierce

E7H01 Answer: D. Colpitts, Hartley and Pierce are all types of oscillator circuits used in Amateur Radio equipment.

Which describes a microphonic?

- A. An IC used for amplifying microphone signals
- B. Distortion caused by RF pickup on the microphone cable
- C. Changes in oscillator frequency due to mechanical vibration
- D. Excess loading of the microphone by an oscillator

E7H02 Answer: C. A microphonic is a change in oscillator frequency due to mechanical vibration.

How is positive feedback supplied in a Hartley oscillator?

- A. Through a tapped coil
- B. Through a capacitive divider
- C. Through link coupling
- D. Through a neutralizing capacitor

E7H03 Answer: A. Positive feedback is supplied through a tapped coil in a Hartley oscillator.

How is positive feedback supplied in a Colpitts oscillator?

- A. Through a tapped coil
- B. Through link coupling
- C. Through a capacitive divider
- D. Through a neutralizing capacitor

E7H04 Answer: C. Positive feedback is supplied through a capacitive divider in a Colpitts oscillator.

How is positive feedback supplied in a Pierce oscillator?

- A. Through a tapped coil
- B. Through link coupling
- C. Through a neutralizing capacitor
- D. Through a quartz crystal

E7H05 Answer: D. Positive feedback is supplied through a quartz crystal in a Pierce oscillator.

Which of the following oscillator circuits are commonly used in VFOs?

- A. Pierce and Zener
- B. Colpitts and Hartley
- C. Armstrong and deForest
- D. Negative feedback and balanced feedback

E7H06 Answer: B. Colpitts and Hartley oscillator circuits are commonly used in VFOs.

How can an oscillator's microphonic responses be reduced?

- A. Use of NP0 capacitors
- B. Eliminating noise on the oscillator's power supply
- C. Using the oscillator only for CW and digital signals
- D. Mechanically isolating the oscillator circuitry from its enclosure

E7H07 Answer: D. An oscillator's microphonic responses can be reduced by mechanically isolating the oscillator circuitry from its enclosure.

Which of the following components can be used to reduce thermal drift in crystal oscillators?

- A. NP0 capacitors
- B. Toroidal inductors
- C. Wirewound resistors
- D. Non-inductive resistors

E7H08 Answer: A. NP0 capacitors can be used to reduce thermal drift in crystal oscillators.

What type of frequency synthesizer circuit uses a phase accumulator, lookup table, digital to analog converter, and a low-pass anti-alias filter?

- A. A direct digital synthesizer
- B. A hybrid synthesizer
- C. A phase locked loop synthesizer
- D. A diode-switching matrix synthesizer

E7H09 Answer: A. A direct digital synthesizer uses a phase accumulator, lookup table, digital to analog converter, and a low-pass anti-alias filter.

What information is contained in the lookup table of a direct digital frequency synthesizer?

- A. The phase relationship between a reference oscillator and the output waveform
- B. The amplitude values that represent a sine-wave output
- C. The phase relationship between a voltage-controlled oscillator and the output waveform
- D. The synthesizer frequency limits and frequency values stored in the radio memories

E7H10 Answer: B. The amplitude values that represent a sine-wave output are contained in the lookup table of a direct digital frequency synthesizer.

What are the major spectral impurity components of direct digital synthesizers?

- A. Broadband noise
- B. Digital conversion noise
- C. Spurious signals at discrete frequencies
- D. Nyquist limit noise

E7H11 Answer: C. The major spectral impurity components of direct digital synthesizers are spurious signals at discrete frequencies.

Which of the following must be done to ensure that a crystal oscillator provides the frequency specified by the crystal manufacturer?

- A. Provide the crystal with a specified parallel inductance
- B. Provide the crystal with a specified parallel capacitance
- C. Bias the crystal at a specified voltage
- D. Bias the crystal at a specified current

E7H12 Answer: B. A crystal oscillator must be provided with a specified parallel capacitance to ensure that it provides the frequency specified by the manufacturer.

Which of the following is a technique for providing highly accurate and stable oscillators needed for microwave transmission and reception?

- A. Use a GPS signal reference
- B. Use a rubidium stabilized reference oscillator
- C. Use a temperature-controlled high Q dielectric resonator
- D. All of these choices are correct

E7H13 Answer: D. GPS signal references, rubidium stabilized reference oscillators, temperature-controlled high Q dielectric resonators can be used for providing highly accurate and stable oscillators needed for microwave transmission and reception.

What is a phase-locked loop circuit?

- A. An electronic servo loop consisting of a ratio detector, reactance modulator, and voltage-controlled oscillator
- B. An electronic circuit also known as a monostable multivibrator
- C. An electronic servo loop consisting of a phase detector, a low-pass filter, a voltage-controlled oscillator, and a stable reference oscillator
- D. An electronic circuit consisting of a precision push-pull amplifier with a differential input

E7H14 Answer: C. A phase-locked loop circuit is an electronic servo loop consisting of a phase detector, a low-pass filter, a voltage-controlled oscillator, and a stable reference oscillator.

Which of these functions can be performed by a phase-locked loop?

- A. Wide-band AF and RF power amplification
- B. Comparison of two digital input signals, digital pulse counter
- C. Photovoltaic conversion, optical coupling
- D. Frequency synthesis, FM demodulation

E7H15 Answer: D. A phase-locked loop can perform frequency synthesis and FM demodulation.

E8 – Signals and Emissions

E8A – AC waveforms: sine, square, sawtooth and irregular waveforms; AC measurements; average and PEP of RF signals; Fourier analysis; Analog to digital conversion: Digital to Analog conversion

What is the name of the process that shows that a square wave is made up of a sine wave plus all of its odd harmonics?

- A. Fourier analysis
- B. Vector analysis
- C. Numerical analysis
- D. Differential analysis

E8A01 Answer: A. Fourier analysis shows that a square wave is made up of a sine wave plus all of its odd harmonics.

What type of wave has a rise time significantly faster than its fall time (or vice versa)?

- A. A cosine wave
- B. A square wave
- C. A sawtooth wave
- D. A sine wave

E8A02 Answer: C. A sawtooth wave has a rise time significantly faster than its fall time (or vice versa).

What type of wave does a Fourier analysis show to be made up of sine waves of a given fundamental frequency plus all of its harmonics?

- A. A sawtooth wave
- B. A square wave
- C. A sine wave
- D. A cosine wave

E8A03 Answer: A. Fourier analysis shows sawtooth waves to be made up of sine waves of a given fundamental frequency plus all of its harmonics.

What is "dither" with respect to analog to digital converters?

- A. An abnormal condition where the converter cannot settle on a value to represent the signal
- B. A small amount of noise added to the input signal to allow more precise representation of a signal over time
- C. An error caused by irregular quantization step size
- D. A method of decimation by randomly skipping samples

E8A04 Answer: B. "Dither" in analog to digital converters is a small amount of noise added to the input signal to allow more precise representation of a signal over time.

What would be the most accurate way of measuring the RMS voltage of a complex waveform?

- A. By using a grid dip meter
- B. By measuring the voltage with a D'Arsonval meter
- C. By using an absorption wave meter
- D. By measuring the heating effect in a known resistor

E8A05 Answer: D. The most accurate way of measuring the RMS voltage of a complex waveform would be measuring the heating effect in a known resistor.

What is the approximate ratio of PEP-to-average power in a typical single-sideband phone signal?

- A. 2.5 to 1
- B. 25 to 1
- C. 1 to 1
- D. 100 to 1

E8A06 Answer: A. The approximate ratio of PEP-to-average power in a typical single-sideband phone signal is 2.5 to 1.

What determines the PEP-to-average power ratio of a single-sideband phone signal?

- A. The frequency of the modulating signal
- B. The characteristics of the modulating signal
- C. The degree of carrier suppression
- D. The amplifier gain

E8A07 Answer: B. The characteristics of the modulating signal determine the PEP-to-average power ratio of a single-sideband phone signal.

Why would a direct or flash conversion analog-to-digital converter be useful for a software-defined radio?

- A. Very low power consumption decreases frequency drift
- B. Immunity to out of sequence coding reduces spurious responses
- C. Very high speed allows digitizing high frequencies
- D. All of these choices are correct

E8A08 Answer: C. A direct or flash conversion analog-to-digital converter would be useful for a software-defined radio because the very high speed allows digitizing high frequencies.

How many levels can an analog-to-digital converter with 8 bit resolution encode?

- A. 8
- B. 8 multiplied by the gain of the input amplifier
- C. 256 divided by the gain of the input amplifier
- D. 256

E8A09 Answer: D. An analog-to-digital converter with 8 bit resolution can encode 256 levels.

What is the purpose of a low pass filter used in conjunction with a digital-to-analog converter?

- A. Lower the input bandwidth to increase the effective resolution
- B. Improve accuracy by removing out of sequence codes from the input
- C. Remove harmonics from the output caused by the discrete analog levels generated
- D. All of these choices are correct

E8A10 Answer: C. A low pass filter used in conjunction with a digital-to-analog converter serves to remove harmonics from the output caused by the discrete analog levels generated.

What type of information can be conveyed using digital waveforms?

- A. Human speech
- B. Video signals
- C. Data
- D. All of these choices are correct

E8A11 Answer: D. Human speech, video signals, and data can all be conveyed using digital waveforms.

What is an advantage of using digital signals instead of analog signals to convey the same information?

- A. Less complex circuitry is required for digital signal generation and detection
- B. Digital signals always occupy a narrower bandwidth
- C. Digital signals can be regenerated multiple times without error
- D. All of these choices are correct

E8A12 Answer: C. An advantage of using digital signals instead of analog signals to convey the same information is that digital signals can be regenerated multiple times without error.

Which of these methods is commonly used to convert analog signals to digital signals?

- A. Sequential sampling
- B. Harmonic regeneration
- C. Level shifting
- D. Phase reversal

E8A13 Answer: A. Sequential sampling is commonly used to convert analog signals to digital signals.

E8B – Modulation and demodulation: modulation methods; modulation index and deviation ratio; frequency and time division multiplexing; Orthogonal Frequency Division Multiplexing

What is the term for the ratio between the frequency deviation of an RF carrier wave and the modulating frequency of its corresponding FM-phone signal?

- A. FM compressibility
- B. Quieting index
- C. Percentage of modulation
- D. Modulation index

E8B01 Answer: D. The ratio between the frequency deviation of an RF carrier wave and the modulating frequency of its corresponding FM-phone signal is the modulation index.

How does the modulation index of a phase-modulated emission vary with RF carrier frequency (the modulated frequency)?

- A. It increases as the RF carrier frequency increases
- B. It decreases as the RF carrier frequency increases
- C. It varies with the square root of the RF carrier frequency
- D. It does not depend on the RF carrier frequency

E8B02 Answer: D. The modulation index of a phase-modulated emission does not depend on the RF carrier frequency.

What is the modulation index of an FM-phone signal having a maximum frequency deviation of 3000 Hz either side of the carrier frequency when the modulating frequency is 1000 Hz?

- A. 3
- B. 0.3
- C. 3000
- D. 1000

E8B03 Answer: A. The modulation index of an FM-phone signal having a maximum frequency deviation of 3000 Hz either side of the carrier frequency when the modulating frequency is 1000 Hz is 3.

What is the modulation index of an FM-phone signal having a maximum carrier deviation of plus or minus 6 kHz when modulated with a 2 kHz modulating frequency?

- A. 6000
- B. 3
- C. 2000
- D. 1/3

E8B04 Answer: B. The modulation index of an FM-phone signal having a maximum carrier deviation of plus or minus 6 kHz when modulated with a 2 kHz modulating frequency is 3.

What is the deviation ratio of an FM-phone signal having a maximum frequency swing of plus-or-minus 5 kHz when the maximum modulation frequency is 3 kHz?

- A. 60
- B. 0.167
- C. 0.6
- D. 1.67

E8B05 Answer: D. The deviation ratio of an FM-phone signal having a maximum frequency swing of plus-or-minus 5 kHz when the maximum modulation frequency is 3 kHz is 1.67.

What is the deviation ratio of an FM-phone signal having a maximum frequency swing of plus or minus 7.5 kHz when the maximum modulation frequency is 3.5 kHz?

- A. 2.14
- B. 0.214
- C. 0.47
- D. 47

E8B06 Answer: A. The deviation ratio of an FM-phone signal having a maximum frequency swing of plus or minus 7.5 kHz when the maximum modulation frequency is 3.5 kHz is 2.14.

Orthogonal Frequency Division Multiplexing is a technique used for which type of amateur communication?

- A. High speed digital modes
- B. Extremely low-power contacts
- C. EME
- D. OFDM signals are not allowed on amateur bands

E8B07 Answer: A. Orthogonal Frequency Division Multiplexing is a technique used for high speed digital modes of amateur communication.

What describes Orthogonal Frequency Division Multiplexing?

- A. A frequency modulation technique which uses non-harmonically related frequencies
- B. A bandwidth compression technique using Fourier transforms
- C. A digital mode for narrow band, slow speed transmissions
- D. A digital modulation technique using subcarriers at frequencies chosen to avoid intersymbol interference

E8B08 Answer: D. Orthogonal Frequency Division Multiplexing is a digital modulation technique using subcarriers at frequencies chosen to avoid intersymbol interference.

What is meant by deviation ratio?

- A. The ratio of the audio modulating frequency to the center carrier frequency
- B. The ratio of the maximum carrier frequency deviation to the highest audio modulating frequency
- C. The ratio of the carrier center frequency to the audio modulating frequency
- D. The ratio of the highest audio modulating frequency to the average audio modulating frequency

E8B09 Answer: B. Deviation ratio is the ratio of the maximum carrier frequency deviation to the highest audio modulating frequency.

What describes frequency division multiplexing?

- A. The transmitted signal jumps from band to band at a predetermined rate
- B. Two or more information streams are merged into a baseband, which then modulates the transmitter
- C. The transmitted signal is divided into packets of information
- D. Two or more information streams are merged into a digital combiner, which then pulse position modulates the transmitter

E8B10 Answer: B. Frequency division multiplexing is when two or more information streams are merged into a baseband, which then modulates the transmitter.

What is digital time division multiplexing?

- A. Two or more data streams are assigned to discrete sub-carriers on an FM transmitter
- B. Two or more signals are arranged to share discrete time slots of a data transmission
- C. Two or more data streams share the same channel by transmitting time of transmission as the sub-carrier
- D. Two or more signals are quadrature modulated to increase bandwidth efficiency

E8B11 Answer: B. Digital time division multiplexing is when two or more signals are arranged to share discrete time slots of a data transmission.

E8C – Digital signals: digital communication modes; information rate vs bandwidth; error correction

How is Forward Error Correction implemented?

- A. By the receiving station repeating each block of three data characters
- B. By transmitting a special algorithm to the receiving station along with the data characters
- C. By transmitting extra data that may be used to detect and correct transmission errors
- D. By varying the frequency shift of the transmitted signal according to a predefined algorithm

E8C01 Answer: C. Forward Error Correction is implemented by transmitting extra data that may be used to detect and correct transmission errors.

What is the definition of symbol rate in a digital transmission?

- A. The number of control characters in a message packet
- B. The duration of each bit in a message sent over the air
- C. The rate at which the waveform of a transmitted signal changes to convey information
- D. The number of characters carried per second by the station-to-station link

E8C02 Answer: C. Symbol rate in a digital transmission is the rate at which the waveform of a transmitted signal changes to convey information.

When performing phase shift keying, why is it advantageous to shift phase precisely at the zero crossing of the RF carrier?

- A. This results in the least possible transmitted bandwidth for the particular mode
- B. It is easier to demodulate with a conventional, non-synchronous detector
- C. It improves carrier suppression
- D. All of these choices are correct

E8C03 Answer: A. When performing phase shift keying, it is advantageous to shift phase precisely at the zero crossing of the RF carrier because it results in the least possible transmitted bandwidth for the particular mode.

What technique is used to minimize the bandwidth requirements of a PSK31 signal?

- A. Zero-sum character encoding
- B. Reed-Solomon character encoding
- C. Use of sinusoidal data pulses
- D. Use of trapezoidal data pulses

E8C04 Answer: C. Use of sinusoidal data pulses helps minimize the bandwidth requirements of a PSK31 signal.

What is the necessary bandwidth of a 13-WPM international Morse code transmission?

- A. Approximately 13 Hz
- B. Approximately 26 Hz
- C. Approximately 52 Hz
- D. Approximately 104 Hz

E8C05 Answer: C. A 13-WPM international Morse code transmission requires a bandwidth of approximately 52 Hz.

What is the necessary bandwidth of a 170-hertz shift, 300-baud ASCII transmission?

- A. 0.1 Hz
- B. 0.3 kHz
- C. 0.5 kHz
- D. 1.0 kHz

E8C06 Answer: C. A 170-hertz shift, 300-baud ASCII transmission requires a bandwidth of 0.5 kHz.

What is the necessary bandwidth of a 4800-Hz frequency shift, 9600-baud ASCII FM transmission?

- A. 15.36 kHz
- B. 9.6 kHz
- C. 4.8 kHz
- D. 5.76 kHz

E8C07 Answer: A. A 4800-Hz frequency shift, 9600-baud ASCII FM transmission requires a bandwidth of 15.36 kHz.

How does ARQ accomplish error correction?

- A. Special binary codes provide automatic correction
- B. Special polynomial codes provide automatic correction
- C. If errors are detected, redundant data is substituted
- D. If errors are detected, a retransmission is requested

E8C08 Answer: D. ARQ accomplishes error correction by requesting a retransmission if errors are detected.

Which is the name of a digital code where each preceding or following character changes by only one bit?

- A. Binary Coded Decimal Code
- B. Extended Binary Coded Decimal Interchange Code
- C. Excess 3 code
- D. Gray code

E8C09 Answer: D. In Gray code, each preceding or following character changes by only one bit.

What is an advantage of Gray code in digital communications where symbols are transmitted as multiple bits?

- A. It increases security
- B. It has more possible states than simple binary
- C. It has more resolution than simple binary
- D. It facilitates error detection

E8C10 Answer: D. An advantage of Gray code in digital communications is that it facilitates error detection.

What is the relationship between symbol rate and baud?

- A. They are the same
- B. Baud is twice the symbol rate
- C. Symbol rate is only used for packet-based modes
- D. Baud is only used for RTTY

E8C11 Answer: A. Symbol rate and baud are the same.

E8D – Keying defects and overmodulation of digital signals; digital codes; spread spectrum

Why are received spread spectrum signals resistant to interference?

- A. Signals not using the spread spectrum algorithm are suppressed in the receiver
- B. The high power used by a spread spectrum transmitter keeps its signal from being easily overpowered
- C. The receiver is always equipped with a digital blanker
- D. If interference is detected by the receiver it will signal the transmitter to change frequencies

E8D01 Answer: A. Received spread spectrum signals are resistant to interference because signals not using the spread spectrum algorithm are suppressed in the receiver.

What spread spectrum communications technique uses a high speed binary bit stream to shift the phase of an RF carrier?

- A. Frequency hopping
- B. Direct sequence
- C. Binary phase-shift keying
- D. Phase companded spread spectrum

E8D02 Answer: B. Direct sequence uses a high speed binary bit stream to shift the phase of an RF carrier.

How does the spread spectrum technique of frequency hopping work?

- A. If interference is detected by the receiver it will signal the transmitter to change frequencies
- B. If interference is detected by the receiver it will signal the transmitter to wait until the frequency is clear
- C. A pseudo-random binary bit stream is used to shift the phase of an RF carrier very rapidly in a particular sequence
- D. The frequency of the transmitted signal is changed very rapidly according to a particular sequence also used by the receiving station

E8D03 Answer: D. In frequency hopping, the frequency of the transmitted signal is changed very rapidly according to a particular sequence also used by the receiving station.

What is the primary effect of extremely short rise or fall time on a CW signal?

- A. More difficult to copy
- B. The generation of RF harmonics
- C. The generation of key clicks
- D. Limits data speed

E8D04 Answer: C. Extremely short rise or fall time on a CW signal lead to the generation of key clicks.

What is the most common method of reducing key clicks?

- A. Increase keying waveform rise and fall times
- B. Low-pass filters at the transmitter output
- C. Reduce keying waveform rise and fall times
- D. High-pass filters at the transmitter output

E8D05 Answer: A. The most common method of reducing key clicks is increasing keying waveform rise and fall times.

Which of the following indicates likely overmodulation of an AFSK signal such as PSK or MFSK?

- A. High reflected power
- B. Strong ALC action
- C. Harmonics on higher bands
- D. Rapid signal fading

E8D06 Answer: B. Strong ALC action indicates likely overmodulation of an AFSK signal such as PSK or MFSK.

What is a common cause of overmodulation of AFSK signals?

- A. Excessive numbers of retries
- B. Ground loops
- C. Bit errors in the modem
- D. Excessive transmit audio levels

E8D07 Answer: D. A common cause of overmodulation of AFSK signals is excessive transmit audio levels.

What parameter might indicate that excessively high input levels are causing distortion in an AFSK signal?

- A. Signal to noise ratio
- B. Baud rate
- C. Repeat Request Rate (RRR)
- D. Intermodulation Distortion (IMD)

E8D08 Answer: D. Intermodulation Distortion (IMD) might indicate that excessively high input levels are causing distortion in an AFSK signal.

What is considered a good minimum IMD level for an idling PSK signal?

- A. +10 dB
- B. +15 dB
- C. -20 dB
- D. -30 dB

E8D09 Answer: D. A good minimum IMD level for an idling PSK signal is -30 dB.

What are some of the differences between the Baudot digital code and ASCII?

- A. Baudot uses 4 data bits per character, ASCII uses 7 or 8; Baudot uses 1 character as a letters/figures shift code, ASCII has no letters/figures code
- B. Baudot uses 5 data bits per character, ASCII uses 7 or 8; Baudot uses 2 characters as letters/figures shift codes, ASCII has no letters/figures shift code
- C. Baudot uses 6 data bits per character, ASCII uses 7 or 8; Baudot has no letters/figures shift code, ASCII uses 2 letters/figures shift codes
- D. Baudot uses 7 data bits per character, ASCII uses 8; Baudot has no letters/figures shift code, ASCII uses 2 letters/figures shift codes

E8D10 Answer: B. Baudot uses 5 data bits per character, ASCII uses 7 or 8; Baudot uses 2 characters as letters/figures shift codes, ASCII has no letters/figures shift code.

What is one advantage of using ASCII code for data communications?

- A. It includes built in error correction features
- B. It contains fewer information bits per character than any other code
- C. It is possible to transmit both upper and lower case text
- D. It uses one character as a shift code to send numeric and special characters

E8D11 Answer: C. An advantage of using ASCII code for data communications is that it is possible to transmit both upper and lower case text.

What is the advantage of including a parity bit with an ASCII character stream?

- A. Faster transmission rate
- B. The signal can overpower interfering signals
- C. Foreign language characters can be sent
- D. Some types of errors can be detected

E8D12 Answer: D. By including a parity bit with an ASCII character stream, some types of errors can be detected.

E9 – Antennas and Transmission Lines

E9A – Basic Antenna parameters: radiation resistance, gain, beamwidth, efficiency, beamwidth; effective radiated power, polarization

What describes an isotropic antenna?

- A. A grounded antenna used to measure earth conductivity
- B. A horizontally polarized antenna used to compare Yagi antennas
- C. A theoretical antenna used as a reference for antenna gain
- D. A spacecraft antenna used to direct signals toward the earth

E9A01 Answer: C. An isotropic antenna is a theoretical antenna used as a reference for antenna gain.

What antenna has no gain in any direction?

- A. Quarter-wave vertical
- B. Yagi
- C. Half-wave dipole
- D. Isotropic antenna

E9A02 Answer: D. An isotropic antenna has no gain in any direction.

Why would one need to know the feed point impedance of an antenna?

- A. To match impedances in order to minimize standing wave ratio on the transmission line
- B. To measure the near-field radiation density from a transmitting antenna
- C. To calculate the front-to-side ratio of the antenna
- D. To calculate the front-to-back ratio of the antenna

E9A03 Answer: A. Knowing the feed point impedance of an antenna allows one to match impedances in order to minimize standing wave ratio on the transmission line.

Which of the following factors may affect the feed point impedance of an antenna?

- A. Transmission-line length
- B. Antenna height, conductor length/diameter ratio and location of nearby conductive objects
- C. The settings of an antenna tuner at the transmitter
- D. Sunspot activity and time of day

E9A04 Answer: B. Antenna height, conductor length/diameter ratio and location of nearby conductive objects may affect the feed point impedance of an antenna.

What is included in the total resistance of an antenna system?

- A. Radiation resistance plus space impedance
- B. Radiation resistance plus transmission resistance
- C. Transmission-line resistance plus radiation resistance
- D. Radiation resistance plus ohmic resistance

E9A05 Answer: D. Radiation resistance plus ohmic resistance is included in the total resistance of an antenna system.

How does the beamwidth of an antenna vary as the gain is increased?

- A. It increases geometrically
- B. It increases arithmetically
- C. It is essentially unaffected
- D. It decreases

E9A06 Answer: D. The beamwidth of an antenna decreases as the gain is increased.

What is meant by antenna gain?

- A. The ratio of the radiated signal strength of an antenna in the direction of maximum radiation to that of a reference antenna
- B. The ratio of the signal in the forward direction to that in the opposite direction
- C. The ratio of the amount of power radiated by an antenna compared to the transmitter output power
- D. The final amplifier gain minus the transmission line losses

E9A07 Answer: A. Antenna gain is the ratio of the radiated signal strength of an antenna in the direction of maximum radiation to that of a reference antenna.

What is meant by antenna bandwidth?

- A. Antenna length divided by the number of elements
- B. The frequency range over which an antenna satisfies a performance requirement
- C. The angle between the half-power radiation points
- D. The angle formed between two imaginary lines drawn through the element ends

E9A08 Answer: B. Antenna bandwidth is the frequency range over which an antenna satisfies a performance requirement.

How is antenna efficiency calculated?

- A. (radiation resistance / transmission resistance) x 100 per cent
- B. (radiation resistance / total resistance) x 100 per cent
- C. (total resistance / radiation resistance) x 100 per cent
- D. (effective radiated power / transmitter output) x 100 percent

E9A09 Answer: B. Antenna efficiency is calculated by (radiation resistance / total resistance) x 100 per cent.

Which of the following choices is a way to improve the efficiency of a ground-mounted quarter-wave vertical antenna?

- A. Install a good radial system
- B. Isolate the coax shield from ground
- C. Shorten the radiating element
- D. Reduce the diameter of the radiating element

E9A10 Answer: A. Installing a good radial system can improve the efficiency of a ground-mounted quarter-wave vertical antenna.

Which of the following factors determines ground losses for a ground-mounted vertical antenna operating in the 3 MHz to 30 MHz range?

- A. The standing wave ratio
- B. Distance from the transmitter
- C. Soil conductivity
- D. Take-off angle

E9A11 Answer: C. Soil conductivity determines ground losses for a ground-mounted vertical antenna operating in the 3 MHz to 30 MHz range.

How much gain does an antenna have compared to a 1/2-wavelength dipole when it has 6 dB gain over an isotropic antenna?

- A. 3.85 dB
- B. 6.0 dB
- C. 8.15 dB
- D. 2.79 dB

E9A12 Answer: A. An antenna has a gain of 3.85 dB compared to a 1/2-wavelength dipole when it has 6 dB gain over an isotropic antenna.

How much gain does an antenna have compared to a 1/2-wavelength dipole when it has 12 dB gain over an isotropic antenna?

- A. 6.17 dB
- B. 9.85 dB
- C. 12.5 dB
- D. 14.15 dB

E9A13 Answer: B. An antenna has a gain of 9.85 dB compared to a 1/2-wavelength dipole when it has 12 dB gain over an isotropic antenna.

What is meant by the radiation resistance of an antenna?

- A. The combined losses of the antenna elements and feed line
- B. The specific impedance of the antenna
- C. The value of a resistance that would dissipate the same amount of power as that radiated from an antenna
- D. The resistance in the atmosphere that an antenna must overcome to be able to radiate a signal

E9A14 Answer: C. The radiation resistance of an antenna is the value of a resistance that would dissipate the same amount of power as that radiated from an antenna.

What is the effective radiated power relative to a dipole of a repeater station with 150 watts transmitter power output, 2 dB feed line loss, 2.2 dB duplexer loss, and 7 dBd antenna gain?

- A. 1977 watts
- B. 78.7 watts
- C. 420 watts
- D. 286 watts

E9A15 Answer: D. The effective radiated power relative to a dipole of a repeater station with 150 watts transmitter power output, 2 dB feed line loss, 2.2 dB duplexer loss, and 7 dBd antenna gain is 286 watts.

What is the effective radiated power relative to a dipole of a repeater station with 200 watts transmitter power output, 4 dB feed line loss, 3.2 dB duplexer loss, 0.8 dB circulator loss, and 10 dBd antenna gain?

- A. 317 watts
- B. 2000 watts
- C. 126 watts
- D. 300 watts

E9A16 Answer: A. The effective radiated power relative to a dipole of a repeater station with 200 watts transmitter power output, 4 dB feed line loss, 3.2 dB duplexer loss, 0.8 dB circulator loss, and 10 dBd antenna gain is 317 watts.

What is the effective radiated power of a repeater station with 200 watts transmitter power output, 2 dB feed line loss, 2.8 dB duplexer loss, 1.2 dB circulator loss, and 7 dBi antenna gain?

- A. 159 watts
- B. 252 watts
- C. 632 watts
- D. 63.2 watts

E9A17 Answer: B. The effective radiated power of a repeater station with 200 watts transmitter power output, 2 dB feed line loss, 2.8 dB duplexer loss, 1.2 dB circulator loss, and 7 dBi antenna gain is 252 watts.

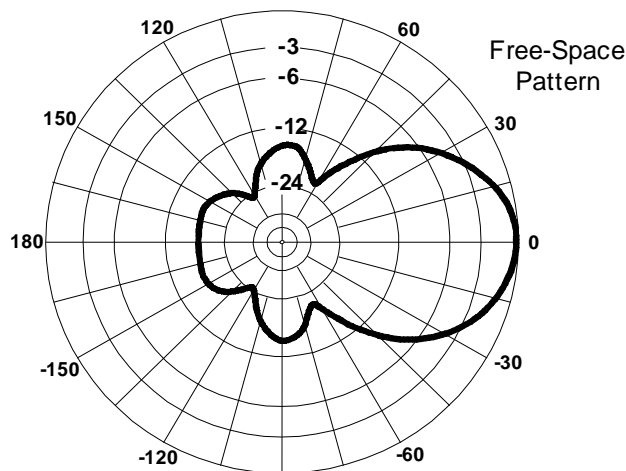
What term describes station output, taking into account all gains and losses?

- A. Power factor
- B. Half-power bandwidth
- C. Effective radiated power
- D. Apparent power

E9A18 Answer: C. Effective radiated power describes station output, taking into account all gains and losses.

E9B – Antenna patterns: E and H plane patterns; gain as a function of pattern; antenna design

Figure E9-1



In the antenna radiation pattern shown in Figure E9-1, what is the 3 dB beam-width?

- A. 75 degrees
- B. 50 degrees
- C. 25 degrees
- D. 30 degrees

E9B01 Answer: B. In the antenna radiation pattern shown in Figure E9-1, the 3 dB beam-width is 50 degrees.

In the antenna radiation pattern shown in Figure E9-1, what is the front-to-back ratio?

- A. 36 dB
- B. 18 dB
- C. 24 dB
- D. 14 dB

E9B02 Answer: B. In the antenna radiation pattern shown in Figure E9-1, the front-to-back ratio is 18 dB.

In the antenna radiation pattern shown in Figure E9-1, what is the front-to-side ratio?

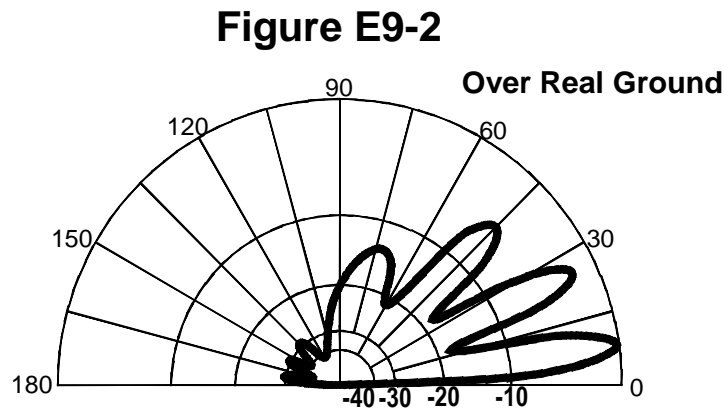
- A. 12 dB
- B. 14 dB
- C. 18 dB
- D. 24 dB

E9B03 Answer: B. In the antenna radiation pattern shown in Figure E9-1, the front-to-side ratio is 14 dB.

What may occur when a directional antenna is operated at different frequencies within the band for which it was designed?

- A. Feed point impedance may become negative
- B. The E-field and H-field patterns may reverse
- C. Element spacing limits could be exceeded
- D. The gain may change depending on frequency

E9B04 Answer: D. The gain may change depending on frequency if a directional antenna is operated at different frequencies within the band for which it was designed.



What type of antenna pattern over real ground is shown in Figure E9-2?

- A. Elevation
- B. Azimuth
- C. Radiation resistance
- D. Polarization

E9B05 Answer: A. An elevation antenna pattern over real ground is shown in Figure E9-2.

What is the elevation angle of peak response in the antenna radiation pattern shown in Figure E9-2?

- A. 45 degrees
- B. 75 degrees
- C. 7.5 degrees
- D. 25 degrees

E9B06 Answer: C. The elevation angle of peak response in the antenna radiation pattern shown in Figure E9-2 is 7.5 degrees.

How does the total amount of radiation emitted by a directional gain antenna compare with the total amount of radiation emitted from an isotropic antenna, assuming each is driven by the same amount of power?

- A. The total amount of radiation from the directional antenna is increased by the gain of the antenna
- B. The total amount of radiation from the directional antenna is stronger by its front-to-back ratio
- C. They are the same
- D. The radiation from the isotropic antenna is 2.15 dB stronger than that from the directional antenna

E9B07 Answer: C. The total amount of radiation emitted by a directional gain antenna is equal to the total amount of radiation emitted from an isotropic antenna, assuming each is driven by the same amount of power.

How can the approximate beam-width in a given plane of a directional antenna be determined?

- A. Note the two points where the signal strength of the antenna is 3 dB less than maximum and compute the angular difference
- B. Measure the ratio of the signal strengths of the radiated power lobes from the front and rear of the antenna
- C. Draw two imaginary lines through the ends of the elements and measure the angle between the lines
- D. Measure the ratio of the signal strengths of the radiated power lobes from the front and side of the antenna

E9B08 Answer: A. The approximate beam-width in a given plane of a directional antenna be determined by noting the two points where the signal strength of the antenna is 3 dB less than maximum and computing the angular difference.

What type of computer program technique is commonly used for modeling antennas?

- A. Graphical analysis
- B. Method of Moments
- C. Mutual impedance analysis
- D. Calculus differentiation with respect to physical properties

E9B09 Answer: B. Method of Moments is a type of computer program technique commonly used for modeling antennas.

What is the principle of a Method of Moments analysis?

- A. A wire is modeled as a series of segments, each having a uniform value of current
- B. A wire is modeled as a single sine-wave current generator
- C. A wire is modeled as a series of points, each having a distinct location in space
- D. A wire is modeled as a series of segments, each having a distinct value of voltage across it

E9B10 Answer: A. In Method of Moments analysis, a wire is modeled as a series of segments, each having a uniform value of current.

What is a disadvantage of decreasing the number of wire segments in an antenna model below the guideline of 10 segments per half-wavelength?

- A. Ground conductivity will not be accurately modeled
- B. The resulting design will favor radiation of harmonic energy
- C. The computed feed point impedance may be incorrect
- D. The antenna will become mechanically unstable

E9B11 Answer: C. Decreasing the number of wire segments in an antenna model below the guideline of 10 segments per half-wavelength may result in the computed feed point impedance being incorrect.

What is the far field of an antenna?

- A. The region of the ionosphere where radiated power is not refracted
- B. The region where radiated power dissipates over a specified time period
- C. The region where radiated field strengths are obstructed by objects of reflection
- D. The region where the shape of the antenna pattern is independent of distance

E9B12 Answer: D. The far field of an antenna is the region where the shape of the antenna pattern is independent of distance.

What does the abbreviation NEC stand for when applied to antenna modeling programs?

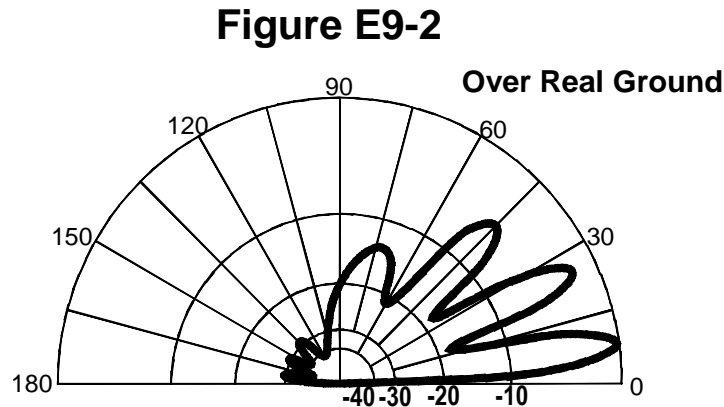
- A. Next Element Comparison
- B. Numerical Electromagnetic Code
- C. National Electrical Code
- D. Numeric Electrical Computation

E9B13 Answer: B. NEC in antenna modeling programs stands for Numerical Electromagnetic Code.

What type of information can be obtained by submitting the details of a proposed new antenna to a modeling program?

- A. SWR vs frequency charts
- B. Polar plots of the far field elevation and azimuth patterns
- C. Antenna gain
- D. All of these choices are correct

E9B14 Answer: D. Submitting the details of a proposed new antenna to a modeling program can provide one with SWR vs. frequency charts, polar plots of the far field elevation and azimuth patterns, and antenna gain.



What is the front-to-back ratio of the radiation pattern shown in Figure E9-2?

- A. 15 dB
- B. 28 dB
- C. 3 dB
- D. 24 dB

E9B15 Answer: B. The front-to-back ratio of the radiation pattern shown in Figure E9-2 is 28 dB.

How many elevation lobes appear in the forward direction of the antenna radiation pattern shown in Figure E9-2?

- A. 4
- B. 3
- C. 1
- D. 7

E9B16 Answer: A. 4 elevation lobes appear in the forward direction of the antenna radiation pattern shown in Figure E9-2.

E9C – Wire and phased array antennas: rhombic antennas; effects of ground reflections; e-off angles; Practical wire antennas: Zepps, OCFD, loops

What is the radiation pattern of two $1/4$ -wavelength vertical antennas spaced $1/2$ -wavelength apart and fed 180 degrees out of phase?

- A. Cardioid
- B. Omni-directional
- C. A figure-8 broadside to the axis of the array
- D. A figure-8 oriented along the axis of the array

E9C01 Answer: D. The radiation pattern of two $1/4$ -wavelength vertical antennas spaced $1/2$ -wavelength apart and fed 180 degrees out of phase is a figure-8 oriented along the axis of the array.

What is the radiation pattern of two $1/4$ wavelength vertical antennas spaced $1/4$ wavelength apart and fed 90 degrees out of phase?

- A. Cardioid
- B. A figure-8 end-fire along the axis of the array
- C. A figure-8 broadside to the axis of the array
- D. Omni-directional

E9C02 Answer: A. The radiation pattern of two $1/4$ wavelength vertical antennas spaced $1/4$ wavelength apart and fed 90 degrees out of phase is a cardioid.

What is the radiation pattern of two $1/4$ wavelength vertical antennas spaced a $1/2$ wavelength apart and fed in phase?

- A. Omni-directional
- B. Cardioid
- C. A Figure-8 broadside to the axis of the array
- D. A Figure-8 end-fire along the axis of the array

E9C03 Answer: C. the radiation pattern of two $1/4$ wavelength vertical antennas spaced a $1/2$ wavelength apart and fed in phase is a figure-8 broadside to the axis of the array.

What happens to the radiation pattern of an unterminated long wire antenna as the wire length is increased?

- A. The lobes become more perpendicular to the wire
- B. The lobes align more in the direction of the wire
- C. The vertical angle increases
- D. The front-to-back ratio decreases

E9C04 Answer: B. The lobes of the radiation pattern align more in the direction of the wire as wire length is increased.

What is an OCFD antenna?

- A. A dipole feed approximately $1/3$ the way from one end with a 4:1 balun to provide multiband operation
- B. A remotely tunable dipole antenna using orthogonally controlled frequency diversity
- C. An eight band dipole antenna using octophase filters
- D. A multiband dipole antenna using one-way circular polarization for frequency diversity

E9C05 Answer: A. An OCFD antenna is a dipole feed approximately $1/3$ the way from one end with a 4:1 balun to provide multiband operation.

What is the effect of a terminating resistor on a rhombic antenna?

- A. It reflects the standing waves on the antenna elements back to the transmitter
- B. It changes the radiation pattern from bidirectional to unidirectional
- C. It changes the radiation pattern from horizontal to vertical polarization
- D. It decreases the ground loss

E9C06 Answer: B. A terminating resistor on a rhombic antenna changes the radiation pattern from bidirectional to unidirectional.

What is the approximate feed point impedance at the center of a two-wire folded dipole antenna?

- A. 300 ohms
- B. 72 ohms
- C. 50 ohms
- D. 450 ohms

E9C07 Answer: A. The approximate feed point impedance at the center of a two-wire folded dipole antenna is 300 ohms.

What is a folded dipole antenna?

- A. A dipole one-quarter wavelength long
- B. A type of ground-plane antenna
- C. A dipole consisting of one wavelength of wire forming a very thin loop
- D. A dipole configured to provide forward gain

E9C08 Answer: C. A folded dipole antenna is a dipole consisting of one wavelength of wire forming a very thin loop.

What is a G5RV antenna?

- A. A multi-band dipole antenna fed with coax and a balun through a selected length of open wire transmission line
- B. A multi-band trap antenna
- C. A phased array antenna consisting of multiple loops
- D. A wide band dipole using shorted coaxial cable for the radiating elements and fed with a 4:1 balun

E9C09 Answer: A. A G5RV antenna is a multi-band dipole antenna fed with coax and a balun through a selected length of open wire transmission line.

Which of the following describes a Zepp antenna?

- A. A dipole constructed from zip cord
- B. An end fed dipole antenna
- C. An omni-directional antenna commonly used for satellite communications
- D. A vertical array capable of quickly changing the direction of maximum radiation by changing phasing lines

E9C10 Answer: B. A Zepp antenna is an end-fed dipole antenna.

How is the far-field elevation pattern of a vertically polarized antenna affected by being mounted over seawater versus rocky ground?

- A. The low-angle radiation decreases
- B. The high-angle radiation increases
- C. Both the high-angle and low-angle radiation decrease
- D. The low-angle radiation increases

E9C11 Answer: D. A vertically polarized antenna mounted over seawater would have more low-angle radiation than one mounted over rocky ground.

Which of the following describes an extended double Zepp antenna?

- A. A wideband vertical antenna constructed from precisely tapered aluminum tubing
- B. A portable antenna erected using two push support poles
- C. A center fed 1.25 wavelength antenna (two 5/8 wave elements in phase)
- D. An end fed folded dipole antenna

E9C12 Answer: C. An extended double Zepp antenna is a center-fed 1.25 wavelength antenna (two 5/8 wave elements in phase).

What is the main effect of placing a vertical antenna over an imperfect ground?

- A. It causes increased SWR
- B. It changes the impedance angle of the matching network
- C. It reduces low-angle radiation
- D. It reduces losses in the radiating portion of the antenna

E9C13 Answer: C. placing a vertical antenna over an imperfect ground results in a reduction of low-angle radiation.

How does the performance of a horizontally polarized antenna mounted on the side of a hill compare with the same antenna mounted on flat ground?

- A. The main lobe takeoff angle increases in the downhill direction
- B. The main lobe takeoff angle decreases in the downhill direction
- C. The horizontal beam width decreases in the downhill direction
- D. The horizontal beam width increases in the uphill direction

E9C14 Answer: B. A horizontally polarized antenna mounted on the side of a hill would have a decreased main lobe takeoff angle in the downhill direction compared to same antenna mounted on flat ground.

How does the radiation pattern of a horizontally polarized 3-element beam antenna vary with its height above ground?

- A. The main lobe takeoff angle increases with increasing height
- B. The main lobe takeoff angle decreases with increasing height
- C. The horizontal beam width increases with height
- D. The horizontal beam width decreases with height

E9C15 Answer: B. The main lobe takeoff angle of a horizontally polarized 3-element beam antenna decreases with increasing height above ground.

E9D – Directional antennas; gain; Yagi Antennas; losses; SWR bandwidth; antenna efficiency; shortened and mobile antennas; RF Grounding

How does the gain of an ideal parabolic dish antenna change when the operating frequency is doubled?

- A. Gain does not change
- B. Gain is multiplied by 0.707
- C. Gain increases by 6 dB
- D. Gain increases by 3 dB

E9D01 Answer: C. The gain of an ideal parabolic dish antenna increases by 6 dB when the operating frequency is doubled.

How can linearly polarized Yagi antennas be used to produce circular polarization?

- A. Stack two Yagis fed 90 degrees out of phase to form an array with the respective elements in parallel planes
- B. Stack two Yagis fed in phase to form an array with the respective elements in parallel planes
- C. Arrange two Yagis perpendicular to each other with the driven elements at the same point on the boom fed 90 degrees out of phase
- D. Arrange two Yagis collinear to each other with the driven elements fed 180 degrees out of phase

E9D02 Answer: C. Placing two Yagis perpendicular to each other with the driven elements at the same point on the boom fed 90 degrees out of phase would result in circular polarization.

Where should a high Q loading coil be placed to minimize losses in a shortened vertical antenna?

- A. Near the center of the vertical radiator
- B. As low as possible on the vertical radiator
- C. As close to the transmitter as possible
- D. At a voltage node

E9D03 Answer: A. A high Q loading coil should be placed near the center of the vertical radiator to minimize losses in a shortened vertical antenna.

Why should an HF mobile antenna loading coil have a high ratio of reactance to resistance?

- A. To swamp out harmonics
- B. To maximize losses
- C. To minimize losses
- D. To minimize the Q

E9D04 Answer: C. An HF mobile antenna loading coil should have a high ratio of reactance to resistance to minimize losses.

What is a disadvantage of using a multiband trapped antenna?

- A. It might radiate harmonics
- B. It radiates the harmonics and fundamental equally well
- C. It is too sharply directional at lower frequencies
- D. It must be neutralized

E9D05 Answer: A. A disadvantage of using a multiband trapped antenna is that it might radiate harmonics.

What happens to the bandwidth of an antenna as it is shortened through the use of loading coils?

- A. It is increased
- B. It is decreased
- C. No change occurs
- D. It becomes flat

E9D06 Answer: B. As an antenna is shortened through the use of loading coils, the bandwidth decreases.

What is an advantage of using top loading in a shortened HF vertical antenna?

- A. Lower Q
- B. Greater structural strength
- C. Higher losses
- D. Improved radiation efficiency

E9D07 Answer: D. Using top loading in a shortened HF vertical antenna results in improved radiation efficiency.

What happens as the Q of an antenna increases?

- A. SWR bandwidth increases
- B. SWR bandwidth decreases
- C. Gain is reduced
- D. More common-mode current is present on the feed line

E9D08 Answer: B. As the Q of an antenna increases, SWR bandwidth decreases.

What is the function of a loading coil used as part of an HF mobile antenna?

- A. To increase the SWR bandwidth
- B. To lower the losses
- C. To lower the Q
- D. To cancel capacitive reactance

E9D09 Answer: D. Loading coils used in HF mobile antennas cancel capacitive reactance.

What happens to feed point impedance at the base of a fixed length HF mobile antenna as the frequency of operation is lowered?

- A. The radiation resistance decreases and the capacitive reactance decreases
- B. The radiation resistance decreases and the capacitive reactance increases
- C. The radiation resistance increases and the capacitive reactance decreases
- D. The radiation resistance increases and the capacitive reactance increases

E9D10 Answer: B. As the frequency of operation is lowered for a fixed-length HF mobile antenna, the radiation resistance decreases and the capacitive reactance increases.

Which of the following types of conductors would be best for minimizing losses in a station's RF ground system?

- A. A resistive wire, such as spark plug wire
- B. A wide flat copper strap
- C. A cable with six or seven 18 gauge conductors in parallel
- D. A single 12 gauge or 10 gauge stainless steel wire

E9D11 Answer: B. A wide flat copper strap would be best for minimizing losses in a station's RF ground system.

Which of the following would provide the best RF ground for your station?

- A. A 50 ohm resistor connected to ground
- B. An electrically short connection to a metal water pipe
- C. An electrically short connection to 3 or 4 interconnected ground rods driven into the Earth
- D. An electrically short connection to 3 or 4 interconnected ground rods via a series RF choke

E9D12 Answer: C. An electrically short connection to 3 or 4 interconnected ground rods driven into the Earth would provide the best RF ground for your station.

What usually occurs if a Yagi antenna is designed solely for maximum forward gain?

- A. The front-to-back ratio increases
- B. The front-to-back ratio decreases
- C. The frequency response is widened over the whole frequency band
- D. The SWR is reduced

E9D13 Answer: B. If a Yagi antenna is designed solely for maximum forward gain, it usually has a low front-to-back ratio.

E9E – Matching: matching antennas to feed lines; phasing lines; power dividers

What system matches a higher impedance transmission line to a lower impedance antenna by connecting the line to the driven element in two places spaced a fraction of a wavelength each side of element center?

- A. The gamma matching system
- B. The delta matching system
- C. The omega matching system
- D. The stub matching system

E9E01 Answer: B. The delta matching system matches a higher impedance transmission line to a lower impedance antenna by connecting the line to the driven element in two places spaced a fraction of a wavelength each side of element center.

What is the name of an antenna matching system that matches an unbalanced feed line to an antenna by feeding the driven element both at the center of the element and at a fraction of a wavelength to one side of center?

- A. The gamma match
- B. The delta match
- C. The epsilon match
- D. The stub match

E9E02 Answer: A. The gamma match matches an unbalanced feed line to an antenna by feeding the driven element both at the center of the element and at a fraction of a wavelength to one side of center.

What is the name of the matching system that uses a section of transmission line connected in parallel with the feed line at or near the feed point?

- A. The gamma match
- B. The delta match
- C. The omega match
- D. The stub match

E9E03 Answer: D. The stub match uses a section of transmission line connected in parallel with the feed line at or near the feed point.

What is the purpose of the series capacitor in a gamma-type antenna matching network?

- A. To provide DC isolation between the feed line and the antenna
- B. To cancel the inductive reactance of the matching network
- C. To provide a rejection notch that prevents the radiation of harmonics
- D. To transform the antenna impedance to a higher value

E9E04 Answer: B. The series capacitor in a gamma-type antenna matching network serves to cancel the inductive reactance of the matching network.

How must the driven element in a 3-element Yagi be tuned to use a hairpin matching system?

- A. The driven element reactance must be capacitive
- B. The driven element reactance must be inductive
- C. The driven element resonance must be lower than the operating frequency
- D. The driven element radiation resistance must be higher than the characteristic impedance of the transmission line

E9E05 Answer: A. The driven element in a 3-element Yagi must be tuned to have capacitive reactance to use a hairpin matching system.

What is the equivalent lumped-constant network for a hairpin matching system of a 3-element Yagi?

- A. Pi-network
- B. Pi-L-network
- C. A shunt inductor
- D. A series capacitor

E9E06 Answer: C. A shunt inductor is the equivalent lumped-constant network for a hairpin matching system of a 3-element Yagi.

What term best describes the interactions at the load end of a mismatched transmission line?

- A. Characteristic impedance
- B. Reflection coefficient
- C. Velocity factor
- D. Dielectric constant

E9E07 Answer: B. Reflection coefficient is the term most applicable to the interactions at the load end of a mismatched transmission line.

Which of the following measurements is characteristic of a mismatched transmission line?

- A. An SWR less than 1:1
- B. A reflection coefficient greater than 1
- C. A dielectric constant greater than 1
- D. An SWR greater than 1:1

E9E08 Answer: D. A mismatched transmission line would have a SWR greater than 1:1.

Which of these matching systems is an effective method of connecting a 50 ohm coaxial cable feed line to a grounded tower so it can be used as a vertical antenna?

- A. Double-bazooka match
- B. Hairpin match
- C. Gamma match
- D. All of these choices are correct

E9E09 Answer: C. Gamma match is an effective method of connecting a 50 ohm coaxial cable feed line to a grounded tower so it can be used as a vertical antenna.

Which of these choices is an effective way to match an antenna with a 100 ohm feed point impedance to a 50 ohm coaxial cable feed line?

- A. Connect a 1/4-wavelength open stub of 300 ohm twin-lead in parallel with the coaxial feed line where it connects to the antenna
- B. Insert a 1/2 wavelength piece of 300 ohm twin-lead in series between the antenna terminals and the 50 ohm feed cable
- C. Insert a 1/4-wavelength piece of 75 ohm coaxial cable transmission line in series between the antenna terminals and the 50 ohm feed cable
- D. Connect 1/2 wavelength shorted stub of 75 ohm cable in parallel with the 50 ohm cable where it attaches to the antenna

E9E10 Answer: C. Inserting a 1/4-wavelength piece of 75 ohm coaxial cable transmission line in series between the antenna terminals and the 50 ohm feed cable would be an effective way to match their impedances.

What is an effective way of matching a feed line to a VHF or UHF antenna when the impedances of both the antenna and feed line are unknown?

- A. Use a 50 ohm 1:1 balun between the antenna and feed line
- B. Use the universal stub matching technique
- C. Connect a series-resonant LC network across the antenna feed terminals
- D. Connect a parallel-resonant LC network across the antenna feed terminals

E9E11 Answer: B. The universal stub matching technique can be used to match unknown impedances.

What is the primary purpose of a phasing line when used with an antenna having multiple driven elements?

- A. It ensures that each driven element operates in concert with the others to create the desired antenna pattern
- B. It prevents reflected power from traveling back down the feed line and causing harmonic radiation from the transmitter
- C. It allows single-band antennas to operate on other bands
- D. It makes sure the antenna has a low-angle radiation pattern

E9E12 Answer: A. A phasing line ensures that each driven element operates in concert with the others to create the desired antenna pattern.

What is a use for a Wilkinson divider?

- A. It divides the operating frequency of a transmitter signal so it can be used on a lower frequency band
- B. It is used to feed high-impedance antennas from a low-impedance source
- C. It is used to divide power equally between two 50 ohm loads while maintaining 50 ohm input impedance
- D. It is used to feed low-impedance loads from a high-impedance source

E9E13 Answer: C. A Wilkinson divider divides the operating frequency of a transmitter signal so it can be used on a lower frequency band.

E9F - Transmission lines: characteristics of open and shorted feed lines; 1/8 wavelength; 1/4 wavelength; 1/2 wavelength; feed lines: coax versus open-wire; velocity factor; electrical length; coaxial cable dielectrics; velocity factor

What is the velocity factor of a transmission line?

- A. The ratio of the characteristic impedance of the line to the terminating impedance
- B. The index of shielding for coaxial cable
- C. The velocity of the wave in the transmission line multiplied by the velocity of light in a vacuum
- D. The velocity of the wave in the transmission line divided by the velocity of light in a vacuum

E9F01 Answer: D. The velocity factor of a transmission line is the velocity of the wave in the transmission line divided by the velocity of light in a vacuum.

Which of the following determines the velocity factor of a transmission line?

- A. The termination impedance
- B. The line length
- C. Dielectric materials used in the line
- D. The center conductor resistivity

E9F02 Answer: C. The dielectric materials used determine the velocity factor of a transmission line.

Why is the physical length of a coaxial cable transmission line shorter than its electrical length?

- A. Skin effect is less pronounced in the coaxial cable
- B. The characteristic impedance is higher in a parallel feed line
- C. The surge impedance is higher in a parallel feed line
- D. Electrical signals move more slowly in a coaxial cable than in air

E9F03 Answer: D. The physical length of a coaxial cable is shorter than its electrical length because electrical signals move more slowly in a coaxial cable than in air.

What is the typical velocity factor for a coaxial cable with solid polyethylene dielectric?

- A. 2.70
- B. 0.66
- C. 0.30
- D. 0.10

E9F04 Answer: B. Coaxial cables with solid polyethylene dielectrics usually have a velocity factor of 0.66.

What is the approximate physical length of a solid polyethylene dielectric coaxial transmission line that is electrically one-quarter wavelength long at 14.1 MHz?

- A. 20 meters
- B. 2.3 meters
- C. 3.5 meters
- D. 0.2 meters

E9F05 Answer: C. A solid polyethylene dielectric coaxial transmission line that is electrically one-quarter wavelength long at 14.1 MHz has an approximate physical length of 3.5 meters.

What is the approximate physical length of an air-insulated, parallel conductor transmission line that is electrically one-half wavelength long at 14.10 MHz?

- A. 15 meters
- B. 20 meters
- C. 10 meters
- D. 71 meters

E9F06 Answer: C. An air-insulated, parallel conductor transmission line that is electrically one-half wavelength long at 14.10 MHz has an approximate physical length of 10 meters.

How does ladder line compare to small-diameter coaxial cable such as RG-58 at 50 MHz?

- A. Lower loss
- B. Higher SWR
- C. Smaller reflection coefficient
- D. Lower velocity factor

E9F07 Answer: A. Ladder line has lower loss than small-diameter coaxial cable such as RG-58 at 50 MHz.

What is the term for the ratio of the actual speed at which a signal travels through a transmission line to the speed of light in a vacuum?

- A. Velocity factor
- B. Characteristic impedance
- C. Surge impedance
- D. Standing wave ratio

E9F08 Answer: A. Velocity factor is the term for the ratio of the actual speed at which a signal travels through a transmission line to the speed of light in a vacuum.

What is the approximate physical length of a solid polyethylene dielectric coaxial transmission line that is electrically one-quarter wavelength long at 7.2 MHz?

- A. 10 meters
- B. 6.9 meters
- C. 24 meters
- D. 50 meters

E9F09 Answer: B. A solid polyethylene dielectric coaxial transmission line that is electrically one-quarter wavelength long at 7.2 MHz has an approximate physical length of 6.9 meters.

What impedance does a $1/8$ wavelength transmission line present to a generator when the line is shorted at the far end?

- A. A capacitive reactance
- B. The same as the characteristic impedance of the line
- C. An inductive reactance
- D. The same as the input impedance to the final generator stage

E9F10 Answer: C. A $1/8$ wavelength transmission line presents an inductive reactance to a generator when the line is shorted at the far end.

What impedance does a $1/8$ wavelength transmission line present to a generator when the line is open at the far end?

- A. The same as the characteristic impedance of the line
- B. An inductive reactance
- C. A capacitive reactance
- D. The same as the input impedance of the final generator stage

E9F11 Answer: C. A $1/8$ wavelength transmission line presents a capacitive reactance to a generator when the line is open at the far end.

What impedance does a $1/4$ wavelength transmission line present to a generator when the line is open at the far end?

- A. The same as the characteristic impedance of the line
- B. The same as the input impedance to the generator
- C. Very high impedance
- D. Very low impedance

E9F12 Answer: D. A $1/4$ wavelength transmission line presents a very low impedance to a generator when the line is open at the far end.

What impedance does a $1/4$ wavelength transmission line present to a generator when the line is shorted at the far end?

- A. Very high impedance
- B. Very low impedance
- C. The same as the characteristic impedance of the transmission line
- D. The same as the generator output impedance

E9F13 Answer: A. A $1/4$ wavelength transmission line presents a very high impedance to a generator when the line is shorted at the far end.

What impedance does a $1/2$ wavelength transmission line present to a generator when the line is shorted at the far end?

- A. Very high impedance
- B. Very low impedance
- C. The same as the characteristic impedance of the line
- D. The same as the output impedance of the generator

E9F14 Answer: B. A $1/2$ wavelength transmission line presents a very low impedance to a generator when the line is shorted at the far end.

What impedance does a 1/2 wavelength transmission line present to a generator when the line is open at the far end?

- A. Very high impedance
- B. Very low impedance
- C. The same as the characteristic impedance of the line
- D. The same as the output impedance of the generator

E9F15 Answer: A. A 1/2 wavelength transmission line presents a very high impedance to a generator when the line is open at the far end.

Which of the following is a significant difference between foam dielectric coaxial cable and solid dielectric cable, assuming all other parameters are the same?

- A. Foam dielectric has lower safe operating voltage limits
- B. Foam dielectric has lower loss per unit of length
- C. Foam dielectric has higher velocity factor
- D. All of these choices are correct

E9F16 Answer: Foam dielectric cable has lower safe operating voltage limits, lower loss per unit of length, and higher velocity factor than solid dielectric cable, assuming all other parameters are the same.

E9G – The Smith chart

Which of the following can be calculated using a Smith chart?

- A. Impedance along transmission lines
- B. Radiation resistance
- C. Antenna radiation pattern
- D. Radio propagation

E9G01 Answer: A. Impedance along transmission lines can be calculated using a Smith chart.

What type of coordinate system is used in a Smith chart?

- A. Voltage circles and current arcs
- B. Resistance circles and reactance arcs
- C. Voltage lines and current chords
- D. Resistance lines and reactance chords

E9G02 Answer: B. Resistance circles and reactance arcs are used in Smith charts.

Which of the following is often determined using a Smith chart?

- A. Beam headings and radiation patterns
- B. Satellite azimuth and elevation bearings
- C. Impedance and SWR values in transmission lines
- D. Trigonometric functions

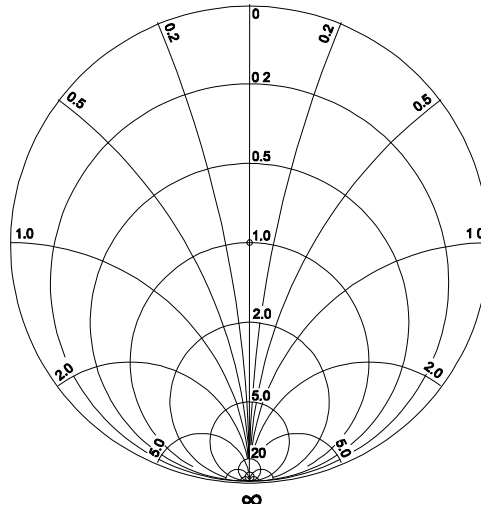
E9G03 Answer: C. Impedance and SWR values in transmission lines are often determined using a Smith chart.

What are the two families of circles and arcs that make up a Smith chart?

- A. Resistance and voltage
- B. Reactance and voltage
- C. Resistance and reactance
- D. Voltage and impedance

E9G04 Answer: C. Resistance and reactance are the two families of circles and arcs that make up a Smith chart.

Figure E9-3



What type of chart is shown in Figure E9-3?

- A. Smith chart
- B. Free space radiation directivity chart
- C. Elevation angle radiation pattern chart
- D. Azimuth angle radiation pattern chart

E9G05 Answer: A. A Smith chart is shown in Figure E9-3.

On the Smith chart shown in Figure E9-3, what is the name for the large outer circle on which the reactance arcs terminate?

- A. Prime axis
- B. Reactance axis
- C. Impedance axis
- D. Polar axis

E9G06 Answer: B. The large outer circle on which the reactance arcs terminate is the reactance axis in Figure E9-3.

On the Smith chart shown in Figure E9-3, what is the only straight line shown?

- A. The reactance axis
- B. The current axis
- C. The voltage axis
- D. The resistance axis

E9G07 Answer: D. On the Smith chart shown in Figure E9-3, the only straight line shown is the resistance axis.

What is the process of normalization with regard to a Smith chart?

- A. Reassigning resistance values with regard to the reactance axis
- B. Reassigning reactance values with regard to the resistance axis
- C. Reassigning impedance values with regard to the prime center
- D. Reassigning prime center with regard to the reactance axis

E9G08 Answer: C. Normalization with regard to a Smith chart is the process of reassigning reactance values with regard to the resistance axis.

What third family of circles is often added to a Smith chart during the process of solving problems?

- A. Standing wave ratio circles
- B. Antenna-length circles
- C. Coaxial-length circles
- D. Radiation-pattern circles

E9G09 Answer: A. Standing wave ratio circles are often added to a Smith chart during the process of solving problems.

What do the arcs on a Smith chart represent?

- A. Frequency
- B. SWR
- C. Points with constant resistance
- D. Points with constant reactance

E9G10 Answer: D. The arcs on a Smith chart represent points with constant reactance.

How are the wavelength scales on a Smith chart calibrated?

- A. In fractions of transmission line electrical frequency
- B. In fractions of transmission line electrical wavelength
- C. In fractions of antenna electrical wavelength
- D. In fractions of antenna electrical frequency

E9G11 Answer: B. The wavelength scales on a Smith chart are calibrated in fractions of transmission line electrical wavelength.

E9H – Receiving Antennas: radio direction finding antennas; Beverage Antennas; specialized receiving antennas; longwire receiving antennas

When constructing a Beverage antenna, which of the following factors should be included in the design to achieve good performance at the desired frequency?

- A. Its overall length must not exceed 1/4 wavelength
- B. It must be mounted more than 1 wavelength above ground
- C. It should be configured as a four-sided loop
- D. It should be one or more wavelengths long

E9H01 Answer: D. Beverage antennas should be one or more wavelengths long.

Which is generally true for low band (160 meter and 80 meter) receiving antennas?

- A. Atmospheric noise is so high that gain over a dipole is not important
- B. They must be erected at least 1/2 wavelength above the ground to attain good directivity
- C. Low loss coax transmission line is essential for good performance
- D. All of these choices are correct

E9H02 Answer: A. The gain of low band (160 meter and 80 meter) receiving antennas is not usually measured with respect to a dipole because atmospheric noise is so high.

What is an advantage of using a shielded loop antenna for direction finding?

- A. It automatically cancels ignition noise in mobile installations
- B. It is electro statically balanced against ground, giving better nulls
- C. It eliminates tracking errors caused by strong out-of-band signals
- D. It allows stations to communicate without giving away their position

E9H04 Answer: B. An advantage of using a shielded loop antenna for direction finding is that it is electrostatically balanced against ground, giving better nulls.

What is the main drawback of a wire-loop antenna for direction finding?

- A. It has a bidirectional pattern
- B. It is non-rotatable
- C. It receives equally well in all directions
- D. It is practical for use only on VHF bands

E9H05 Answer: A. The main drawback of a wire-loop antenna for direction finding is that it has a bidirectional pattern.

What is the triangulation method of direction finding?

- A. The geometric angles of sky waves from the source are used to determine its position
- B. A fixed receiving station plots three headings to the signal source
- C. Antenna headings from several different receiving locations are used to locate the signal source
- D. A fixed receiving station uses three different antennas to plot the location of the signal source

E9H06 Answer: C. The triangulation method of direction finding involves using antenna headings from several different receiving locations to locate the signal source.

Why is it advisable to use an RF attenuator on a receiver being used for direction finding?

- A. It narrows the bandwidth of the received signal to improve signal to noise ratio
- B. It compensates for the effects of an isotropic antenna, thereby improving directivity
- C. It reduces loss of received signals caused by antenna pattern nulls, thereby increasing sensitivity
- D. It prevents receiver overload which could make it difficult to determine peaks or nulls

E9H07 Answer: D. An RF attenuator on a receiver being used for direction finding prevents receiver overload.

What is the function of a sense antenna?

- A. It modifies the pattern of a DF antenna array to provide a null in one direction
- B. It increases the sensitivity of a DF antenna array
- C. It allows DF antennas to receive signals at different vertical angles
- D. It provides diversity reception that cancels multipath signals

E9H08 Answer: A. A sense antenna modifies the pattern of a DF antenna array to provide a null in one direction.

Which of the following describes the construction of a receiving loop antenna?

- A. A large circularly polarized antenna
- B. A small coil of wire tightly wound around a toroidal ferrite core
- C. One or more turns of wire wound in the shape of a large open coil
- D. A vertical antenna coupled to a feed line through an inductive loop of wire

E9H09 Answer: C. A receiving loop antenna is one or more turns of wire wound in the shape of a large open coil.

How can the output voltage of a multiple turn receiving loop antenna be increased?

- A. By reducing the permeability of the loop shield
- B. By increasing the number of wire turns in the loop and reducing the area of the loop structure
- C. By winding adjacent turns in opposing directions
- D. By increasing either the number of wire turns in the loop or the area of the loop structure or both

E9H10 Answer: D. The output voltage of a multiple turn receiving loop antenna can be increased by increasing either the number of wire turns in the loop or the area of the loop structure or both.

What characteristic of a cardioid pattern antenna is useful for direction finding?

- A. A very sharp peak
- B. A very sharp single null
- C. Broad band response
- D. High-radiation angle

E9H11 Answer: B. The very sharp single null part of a cardioid pattern antenna is useful for direction finding.

E0 – Safety

E0A – Safety: amateur radio safety practices; RF radiation hazards; hazardous materials; grounding

What is the primary function of an external earth connection or ground rod?

- A. Reduce received noise
- B. Lightning protection
- C. Reduce RF current flow between pieces of equipment
- D. Reduce RFI to telephones and home entertainment systems

E0A01 Answer: B. The primary function of an external earth connection or ground rod is lightning protection.

When evaluating RF exposure levels from your station at a neighbor's home, what must you do?

- A. Make sure signals from your station are less than the controlled MPE limits
- B. Make sure signals from your station are less than the uncontrolled MPE limits
- C. You need only evaluate exposure levels on your own property
- D. Advise your neighbors of the results of your tests

E0A02 Answer: B. You must make sure signals from your station are less than the uncontrolled MPE limits.

Which of the following would be a practical way to estimate whether the RF fields produced by an amateur radio station are within permissible MPE limits?

- A. Use a calibrated antenna analyzer
- B. Use a hand calculator plus Smith-chart equations to calculate the fields
- C. Use an antenna modeling program to calculate field strength at accessible locations
- D. All of the choices are correct

E0A03 Answer: C. Using an antenna modeling program to calculate field strength at accessible locations is a practical way to estimate whether the RF fields produced by an amateur radio station are within permissible MPE limits.

When evaluating a site with multiple transmitters operating at the same time, the operators and licensees of which transmitters are responsible for mitigating over-exposure situations?

- A. Only the most powerful transmitter
- B. Only commercial transmitters
- C. Each transmitter that produces 5 percent or more of its MPE limit at accessible locations
- D. Each transmitter operating with a duty-cycle greater than 50 percent

E0A04 Answer: C. When evaluating a site with multiple transmitters operating at the same time, the operators and licensees of each transmitter that produces 5 percent or more of its MPE limit at accessible locations are responsible for mitigating over-exposure situations.

What is one of the potential hazards of using microwaves in the amateur radio bands?

- A. Microwaves are ionizing radiation
- B. The high gain antennas commonly used can result in high exposure levels
- C. Microwaves often travel long distances by ionospheric reflection
- D. The extremely high frequency energy can damage the joints of antenna structures

E0A05 Answer: B. One of the potential hazards of using microwaves in the amateur radio bands is that the high gain antennas commonly used can result in high exposure levels.

Why are there separate electric (E) and magnetic (H) field MPE limits?

- A. The body reacts to electromagnetic radiation from both the E and H fields
- B. Ground reflections and scattering make the field impedance vary with location
- C. E field and H field radiation intensity peaks can occur at different locations
- D. All of these choices are correct

E0A06 Answer: D. There are multiple reasons why there are separate electric (E) and magnetic (H) field MPE limits, including different body reactions, varying field impedance due to ground reflections and scattering, and different radiation intensity peaks.

How may dangerous levels of carbon monoxide from an emergency generator be detected?

- A. By the odor
- B. Only with a carbon monoxide detector
- C. Any ordinary smoke detector can be used
- D. By the yellowish appearance of the gas

E0A07 Answer: B. Dangerous levels of carbon monoxide from an emergency generator can be detected only with a carbon monoxide detector.

What does SAR measure?

- A. Synthetic Aperture Ratio of the human body
- B. Signal Amplification Rating
- C. The rate at which RF energy is absorbed by the body
- D. The rate of RF energy reflected from stationary terrain

E0A08 Answer: C. SAR measures the rate at which RF energy is absorbed by the body.

Which insulating material commonly used as a thermal conductor for some types of electronic devices is extremely toxic if broken or crushed and the particles are accidentally inhaled?

- A. Mica
- B. Zinc oxide
- C. Beryllium Oxide
- D. Uranium Hexafluoride

E0A09 Answer: C. Beryllium Oxide is extremely toxic if broken or crushed and the particles are accidentally inhaled.

What toxic material may be present in some electronic components such as high voltage capacitors and transformers?

- A. Polychlorinated Biphenyls
- B. Polyethylene
- C. Polytetrafluorethylene
- D. Polymorphic silicon

E0A10 Answer: A. Polychlorinated biphenyls may be present in some electronic components such as high voltage capacitors and transformers.

Which of the following injuries can result from using high-power UHF or microwave transmitters?

- A. Hearing loss caused by high voltage corona discharge
- B. Blood clotting from the intense magnetic field
- C. Localized heating of the body from RF exposure in excess of the MPE limits
- D. Ingestion of ozone gas from the cooling system

E0A11 Answer: C. Localized heating of the body can occur from RF exposure in excess of the MPE limits.

NOTE: The graphics required for certain questions in sections E5, E6, E7, and E9 are included on the following pages:

Ham Radio Extra Class Practice Tests

Test #1 Practice Questions

1. When using a transceiver that displays the carrier frequency of phone signals, which of the following displayed frequencies represents the highest frequency at which a properly adjusted USB emission will be totally within the band?
 - a. The exact upper band edge
 - b. 300 Hz below the upper band edge
 - c. 1 kHz below the upper band edge
 - d. 3 kHz below the upper band edge

2. Which of the following constitutes a spurious emission?
 - a. An amateur station transmission made at random without the proper call sign identification
 - b. A signal transmitted to prevent its detection by any station other than the intended recipient
 - c. Any transmitted signal that unintentionally interferes with another licensed radio station
 - d. An emission outside its necessary bandwidth that can be reduced or eliminated without affecting the information transmitted

3. What is a remotely controlled station?
 - a. A station operated away from its regular home location
 - b. A station controlled by someone other than the licensee
 - c. A station operating under automatic control
 - d. A station controlled indirectly through a control link

4. What is the definition of the term telemetry?
 - a. One-way transmission of measurements at a distance from the measuring instrument
 - b. Two-way radiotelephone transmissions in excess of 1000 feet
 - c. Two-way single channel transmissions of data
 - d. One-way transmission that initiates, modifies, or terminates the functions of a device at a distance

5. What is the minimum number of qualified VEs required to administer an Element 4 amateur operator license examination?
 - a. 5
 - b. 2
 - c. 4
 - d. 3

6. On what frequencies are spread spectrum transmissions permitted?
 - a. Only on amateur frequencies above 50 MHz
 - b. Only on amateur frequencies above 222 MHz
 - c. Only on amateur frequencies above 420 MHz
 - d. Only on amateur frequencies above 144 MHz

7. What is the direction of an ascending pass for an amateur satellite?
 - a. From west to east
 - b. From east to west
 - c. From south to north
 - d. From north to south

8. How many times per second is a new frame transmitted in a fast-scan (NTSC) television system?
 - a. 30
 - b. 60
 - c. 90
 - d. 120

9. Which of the following is true about contest operating?
 - a. Operators are permitted to make contacts even if they do not submit a log
 - b. Interference to other amateurs is unavoidable and therefore acceptable
 - c. It is mandatory to transmit the call sign of the station being worked as part of every transmission to that station
 - d. Every contest requires a signal report in the exchange

10. Which of the following digital modes is especially designed for use for meteor scatter signals?
 - a. WSPR
 - b. FSK441
 - c. Hellschreiber
 - d. APRS

11. Which type of modulation is common for data emissions below 30 MHz?
 - a. DTMF tones modulating an FM signal
 - b. FSK
 - c. Pulse modulation
 - d. Spread spectrum

12. What is the approximate maximum separation measured along the surface of the Earth between two stations communicating by Moon bounce?
 - a. 500 miles, if the Moon is at perigee
 - b. 2000 miles, if the Moon is at apogee
 - c. 5000 miles, if the Moon is at perigee
 - d. 12,000 miles, if the Moon is visible by both stations

13. What is transequatorial propagation?
 - a. Propagation between two mid-latitude points at approximately the same distance north and south of the magnetic equator
 - b. Propagation between any two points located on the magnetic equator
 - c. Propagation between two continents by way of ducts along the magnetic equator
 - d. Propagation between two stations at the same latitude

14. What does the term ray tracing describe in regard to radio communications?
- The process in which an electronic display presents a pattern
 - Modeling a radio wave's path through the ionosphere
 - Determining the radiation pattern from an array of antennas
 - Evaluating high voltage sources for X-Rays
15. Which of the following parameter determines the bandwidth of a digital or computer-based oscilloscope?
- Input capacitance
 - Input impedance
 - Sampling rate
 - Sample resolution
16. Which of the following factors most affects the accuracy of a frequency counter?
- Input attenuator accuracy
 - Time base accuracy
 - Decade divider accuracy
 - Temperature coefficient of the logic
17. What is an effect of excessive phase noise in the local oscillator section of a receiver?
- It limits the receiver's ability to receive strong signals
 - It reduces receiver sensitivity
 - It decreases receiver third-order intermodulation distortion dynamic range
 - It can cause strong signals on nearby frequencies to interfere with reception of weak signals
18. What is meant by the blocking dynamic range of a receiver?
- The difference in dB between the noise floor and the level of an incoming signal which will cause 1 dB of gain compression
 - The minimum difference in dB between the levels of two FM signals which will cause one signal to block the other
 - The difference in dB between the noise floor and the third order intercept point
 - The minimum difference in dB between two signals which produce third order intermodulation products greater than the noise floor
19. Which of the following types of receiver noise can often be reduced by use of a receiver noise blanker?
- Ignition noise
 - Broadband white noise
 - Heterodyne interference
 - All of these choices are correct
20. What can cause the voltage across reactances in series to be larger than the voltage applied to them?
- Resonance
 - Capacitance
 - Conductance
 - Resistance

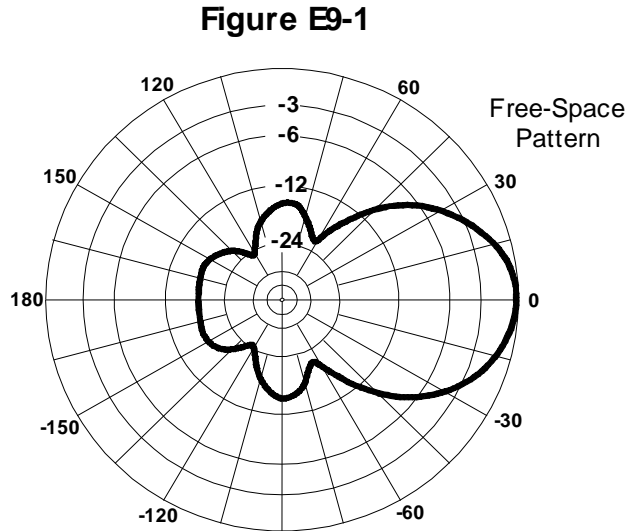
21. What is the term for the time required for the capacitor in an RC circuit to be charged to 63.2% of the applied voltage?
- An exponential rate of one
 - One time constant
 - One exponential period
 - A time factor of one
22. Which of the following represents a capacitive reactance in rectangular notation?
- $-jX$
 - $+jX$
 - X
 - Omega
23. What is the result of skin effect?
- As frequency increases, RF current flows in a thinner layer of the conductor, closer to the surface
 - As frequency decreases, RF current flows in a thinner layer of the conductor, closer to the surface
 - Thermal effects on the surface of the conductor increase the impedance
 - Thermal effects on the surface of the conductor decrease the impedance
24. In what application is gallium arsenide used as a semiconductor material in preference to germanium or silicon?
- In high-current rectifier circuits
 - In high-power audio circuits
 - In microwave circuits
 - In very low frequency RF circuits
25. What is the most useful characteristic of a Zener diode?
- A constant current drop under conditions of varying voltage
 - A constant voltage drop under conditions of varying current
 - A negative resistance region
 - An internal capacitance that varies with the applied voltage
26. What is the function of hysteresis in a comparator?
- To prevent input noise from causing unstable output signals
 - To allow the comparator to be used with AC input signal
 - To cause the output to change states continually
 - To increase the sensitivity
27. How many turns will be required to produce a 5-microhenry inductor using a powdered-iron toroidal core that has an inductance index (AL) value of 40 microhenrys/100 turns?
- 35 turns
 - 13 turns
 - 79 turns
 - 141 turns

28. Which of the following is true of a charge-coupled device (CCD)?
- Its phase shift changes rapidly with frequency
 - It is a CMOS analog-to-digital converter
 - It samples an analog signal and passes it in stages from the input to the output
 - It is used in a battery charger circuit
29. What is photoconductivity?
- The conversion of photon energy to electromotive energy
 - The increased conductivity of an illuminated semiconductor
 - The conversion of electromotive energy to photon energy
 - The decreased conductivity of an illuminated semiconductor
30. Which is a bi-stable circuit?
- An "AND" gate
 - An "OR" gate
 - A flip-flop
 - A clock
31. For what portion of a signal cycle does a Class AB amplifier operate?
- More than 180 degrees but less than 360 degrees
 - Exactly 180 degrees
 - The entire cycle
 - Less than 180 degrees
32. How are the capacitors and inductors of a low-pass filter Pi-network arranged between the network's input and output?
- Two inductors are in series between the input and output, and a capacitor is connected between the two inductors and ground
 - Two capacitors are in series between the input and output, and an inductor is connected between the two capacitors and ground
 - An inductor is connected between the input and ground, another inductor is connected between the output and ground, and a capacitor is connected between the input and output
 - A capacitor is connected between the input and ground, another capacitor is connected between the output and ground, and an inductor is connected between input and output
33. What is one characteristic of a linear electronic voltage regulator?
- It has a ramp voltage as its output
 - It eliminates the need for a pass transistor
 - The control element duty cycle is proportional to the line or load conditions
 - The conduction of a control element is varied to maintain a constant output voltage
34. Which of the following can be used to generate FM phone emissions?
- A balanced modulator on the audio amplifier
 - A reactance modulator on the oscillator
 - A reactance modulator on the final amplifier
 - A balanced modulator on the oscillator

35. What is meant by direct digital conversion as applied to software defined radios?
- Software is converted from source code to object code during operation of the receiver
 - Incoming RF is converted to a control voltage for a voltage controlled oscillator
 - Incoming RF is digitized by an analog-to-digital converter without being mixed with a local oscillator signal
 - A switching mixer is used to generate I and Q signals directly from the RF input
36. What is the typical output impedance of an integrated circuit op-amp?
- Very low
 - Very high
 - 100 ohms
 - 1000 ohms
37. What are three oscillator circuits used in Amateur Radio equipment?
- Taft, Pierce and negative feedback
 - Pierce, Fenner and Beane
 - Taft, Hartley and Pierce
 - Colpitts, Hartley and Pierce
38. What is the name of the process that shows that a square wave is made up of a sine wave plus all of its odd harmonics?
- Fourier analysis
 - Vector analysis
 - Numerical analysis
 - Differential analysis
39. What is the term for the ratio between the frequency deviation of an RF carrier wave and the modulating frequency of its corresponding FM-phone signal?
- FM compressibility
 - Quieting index
 - Percentage of modulation
 - Modulation index
40. How is Forward Error Correction implemented?
- By the receiving station repeating each block of three data characters
 - By transmitting a special algorithm to the receiving station along with the data characters
 - By transmitting extra data that may be used to detect and correct transmission errors
 - By varying the frequency shift of the transmitted signal according to a predefined algorithm
41. Why are received spread spectrum signals resistant to interference?
- Signals not using the spread spectrum algorithm are suppressed in the receiver
 - The high power used by a spread spectrum transmitter keeps its signal from being easily overpowered
 - The receiver is always equipped with a digital blanker
 - If interference is detected by the receiver it will signal the transmitter to change frequencies

42. What describes an isotropic antenna?
- A grounded antenna used to measure earth conductivity
 - A horizontally polarized antenna used to compare Yagi antennas
 - A theoretical antenna used as a reference for antenna gain
 - A spacecraft antenna used to direct signals toward the earth

Question 43 pertains to the following graphic:



43. In the antenna radiation pattern shown in Figure E9-1, what is the 3 dB beam-width?
- 75 degrees
 - 50 degrees
 - 25 degrees
 - 30 degrees
44. What is the radiation pattern of two $1/4$ -wavelength vertical antennas spaced $1/2$ -wavelength apart and fed 180 degrees out of phase?
- Cardioid
 - Omni-directional
 - A figure-8 broadside to the axis of the array
 - A figure-8 oriented along the axis of the array
45. How does the gain of an ideal parabolic dish antenna change when the operating frequency is doubled?
- Gain does not change
 - Gain is multiplied by 0.707
 - Gain increases by 6 dB
 - Gain increases by 3 dB

46. What system matches a higher impedance transmission line to a lower impedance antenna by connecting the line to the driven element in two places spaced a fraction of a wavelength each side of element center?
- The gamma matching system
 - The delta matching system
 - The omega matching system
 - The stub matching system
47. What is the velocity factor of a transmission line?
- The ratio of the characteristic impedance of the line to the terminating impedance
 - The index of shielding for coaxial cable
 - The velocity of the wave in the transmission line multiplied by the velocity of light in a vacuum
 - The velocity of the wave in the transmission line divided by the velocity of light in a vacuum
48. Which of the following can be calculated using a Smith chart?
- Impedance along transmission lines
 - Radiation resistance
 - Antenna radiation pattern
 - Radio propagation
49. When constructing a Beverage antenna, which of the following factors should be included in the design to achieve good performance at the desired frequency?
- Its overall length must not exceed $1/4$ wavelength
 - It must be mounted more than 1 wavelength above ground
 - It should be configured as a four-sided loop
 - It should be one or more wavelengths long
50. What is the primary function of an external earth connection or ground rod?
- Reduce received noise
 - Lightning protection
 - Reduce RF current flow between pieces of equipment
 - Reduce RFI to telephones and home entertainment systems

Test #1 Answer Key and Explanations

1. D: The highest frequency at which a properly adjusted USB emission will be totally within the band is 3 kHz below the upper band edge.
2. D: A spurious emission is an emission outside its necessary bandwidth that can be reduced or eliminated without affecting the information transmitted.
3. D: A remotely controlled station is a station controlled indirectly through a control link.
4. A: Telemetry is one-way transmission of measurements at a distance from the measuring instrument.
5. D: The minimum number of qualified VEs required to administer an Element 4 amateur operator license examination is 3.
6. B: spread spectrum transmissions are permitted only on amateur frequencies above 222 MHz.
7. C: An amateur satellite goes from south to north in an ascending pass.
8. A: A new frame transmitted 30 times per second in a fast-scan (NTSC) television system.
9. A: In contest operating, operators are permitted to make contacts even if they do not submit a log.
10. B: The FSK441 digital mode is especially designed for use for meteor scatter signals.
11. B: FSK modulation is common for data emissions below 30 MHz.
12. D: The approximate maximum separation measured along the surface of the Earth between two stations communicating by Moon bounce is 12,000 miles, if the Moon is visible by both stations.
13. A: Transequatorial propagation is propagation between two mid-latitude points at approximately the same distance north and south of the magnetic equator.
14. B: Ray tracing is modeling a radio wave's path through the ionosphere.
15. C: Sampling rate determines the bandwidth of a digital or computer-based oscilloscope.
16. B: Time base accuracy most affects the overall accuracy of a frequency counter.
17. D: Excessive phase noise in the local oscillator section of a receiver can cause strong signals on nearby frequencies to interfere with reception of weak signals.
18. A: The blocking dynamic range of a receiver is the difference in dB between the noise floor and the level of an incoming signal which will cause 1 dB of gain compression
19. A: Ignition noise can often be reduced by use of a receiver noise blanker.
20. A: Resonance can cause the voltage across reactances in series to be larger than the voltage applied to them.
21. B: A time-constant is the time required for the capacitor in an RC circuit to be charged to 63.2% of the applied voltage.

22. A: “ $-jX$ ” represents a capacitive reactance in rectangular notation.
23. A: As a result of skin effect, as frequency increases, RF current flows in a thinner layer of the conductor, closer to the surface.
24. C: Gallium arsenide is used as a semiconductor material in preference to germanium or silicon in microwave circuits.
25. B: Zener diodes are most useful because they have a constant voltage drop under conditions of varying current.
26. A: Hysteresis in a comparator prevents input noise from causing unstable output signals.
27. A: 35 turns will be required to produce a 5-microhenry inductor using a powdered-iron toroidal core that has an inductance index (AL) value of 40 microhenrys/100 turns.
28. C: A charge-coupled device (CCD) samples an analog signal and passes it in stages from the input to the output.
29. B: Photoconductivity is the increased conductivity of an illuminated semiconductor.
30. C: Flip-flops are bi-stable circuits.
31. A: A class AB amplifier operates on more than 180 degrees but less than 360 degrees of a signal cycle.
32. D: In a low-pass filter Pi-network, a capacitor is connected between the input and ground, another capacitor is connected between the output and ground, and an inductor is connected between input and output.
33. D: A linear electronic voltage regulator varies the conduction of a control element to maintain a constant output voltage.
34. B: A reactance modulator on the oscillator can be used to generate FM phone emissions.
35. C: Direct digital conversion is when incoming RF is digitized by an analog-to-digital converter without being mixed with a local oscillator signal.
36. A: The typical output impedance of an integrated circuit op-amp is very low.
37. D: Colpitts, Hartley and Pierce are all types of oscillator circuits used in Amateur Radio equipment.
38. A: Fourier analysis shows that a square wave is made up of a sine wave plus all of its odd harmonics.
39. D: The ratio between the frequency deviation of an RF carrier wave and the modulating frequency of its corresponding FM-phone signal is the modulation index.
40. C: Forward Error Correction is implemented by transmitting extra data that may be used to detect and correct transmission errors.
41. A: Received spread spectrum signals are resistant to interference because signals not using the spread spectrum algorithm are suppressed in the receiver.

42. C: An isotropic antenna is a theoretical antenna used as a reference for antenna gain.
43. B: In the antenna radiation pattern shown in Figure E9-1, the 3 dB beam-width is 50 degrees.
44. D: The radiation pattern of two $1/4$ -wavelength vertical antennas spaced $1/2$ -wavelength apart and fed 180 degrees out of phase is a figure-8 oriented along the axis of the array.
45. C: The gain of an ideal parabolic dish antenna increases by 6 dB when the operating frequency is doubled.
46. B: The delta matching system matches a higher impedance transmission line to a lower impedance antenna by connecting the line to the driven element in two places spaced a fraction of a wavelength each side of element center.
47. D: The velocity factor of a transmission line is the velocity of the wave in the transmission line divided by the velocity of light in a vacuum.
48. A: Impedance along transmission lines can be calculated using a Smith chart.
49. D: Beverage antennas should be one or more wavelengths long.
50. B: The primary function of an external earth connection or ground rod is lightning protection.

Test #2 Practice Questions

1. When using a transceiver that displays the carrier frequency of phone signals, which of the following displayed frequencies represents the lowest frequency at which a properly adjusted LSB emission will be totally within the band?
 - a. The exact lower band edge
 - b. 300 Hz above the lower band edge
 - c. 1 kHz above the lower band edge
 - d. 3 kHz above the lower band edge

2. Which of the following factors might cause the physical location of an amateur station apparatus or antenna structure to be restricted?
 - a. The location is near an area of political conflict
 - b. The location is of geographical or horticultural importance
 - c. The location is in an ITU Zone designated for coordination with one or more foreign governments
 - d. The location is of environmental importance or significant in American history, architecture, or culture

3. What is meant by automatic control of a station?
 - a. The use of devices and procedures for control so that the control operator does not have to be present at a control point
 - b. A station operating with its output power controlled automatically
 - c. Remotely controlling a station's antenna pattern through a directional control link
 - d. The use of a control link between a control point and a locally controlled station

4. What is the amateur satellite service?
 - a. A radio navigation service using satellites for the purpose of self training, intercommunication and technical studies carried out by amateurs
 - b. A spacecraft launching service for amateur-built satellites
 - c. A radio communications service using amateur radio stations on satellites
 - d. A radio communications service using stations on Earth satellites for public service broadcast

5. Where are the questions for all written U.S. amateur license examinations listed?
 - a. In FCC Part 97
 - b. In a question pool maintained by the FCC
 - c. In a question pool maintained by all the VECs
 - d. In the appropriate FCC Report and Order

6. What privileges are authorized in the U.S. to persons holding an amateur service license granted by the Government of Canada?
 - a. None, they must obtain a U.S. license
 - b. All privileges of the Extra Class license
 - c. The operating terms and conditions of the Canadian amateur service license, not to exceed U.S. Extra Class privileges
 - d. Full privileges, up to and including those of the Extra Class License, on the 80, 40, 20, 15, and 10 meter bands

7. What is the direction of a descending pass for an amateur satellite?
 - a. From north to south
 - b. From west to east
 - c. From east to west
 - d. From south to north

8. How many horizontal lines make up a fast-scan (NTSC) television frame?
 - a. 30
 - b. 60
 - c. 525
 - d. 1080

9. Which of the following best describes the term self-spotting in regards to HF contest operating?
 - a. The generally prohibited practice of posting one's own call sign and frequency on a spotting network
 - b. The acceptable practice of manually posting the call signs of stations on a spotting network
 - c. A manual technique for rapidly zero beating or tuning to a station's frequency before calling that station
 - d. An automatic method for rapidly zero beating or tuning to a station's frequency before calling that station

10. Which of the following is a good technique for making meteor scatter contacts?
 - a. 15 second timed transmission sequences with stations alternating based on location
 - b. Use of high speed CW or digital modes
 - c. Short transmission with rapidly repeated call signs and signal reports
 - d. All of these choices are correct

11. What do the letters FEC mean as they relate to digital operation?
 - a. Forward Error Correction
 - b. First Error Correction
 - c. Fatal Error Correction
 - d. Final Error Correction

12. What characterizes libration fading of an EME signal?
 - a. A slow change in the pitch of the CW signal
 - b. A fluttery irregular fading
 - c. A gradual loss of signal as the Sun rises
 - d. The returning echo is several Hertz lower in frequency than the transmitted signal

13. What is the approximate maximum range for signals using transequatorial propagation?
 - a. 1000 miles
 - b. 2500 miles
 - c. 5000 miles
 - d. 7500 miles

14. What is indicated by a rising A or K index?
- Increasing disruption of the geomagnetic field
 - Decreasing disruption of the geomagnetic field
 - Higher levels of solar UV radiation
 - An increase in the critical frequency
15. Which of the following parameters would a spectrum analyzer display on the vertical and horizontal axes?
- RF amplitude and time
 - RF amplitude and frequency
 - SWR and frequency
 - SWR and time
16. What is an advantage of using a bridge circuit to measure impedance?
- It provides an excellent match under all conditions
 - It is relatively immune to drift in the signal generator source
 - It is very precise in obtaining a signal null
 - It can display results directly in Smith chart format
17. Which of the following portions of a receiver can be effective in eliminating image signal interference?
- A front-end filter or pre-selector
 - A narrow IF filter
 - A notch filter
 - A properly adjusted product detector
18. Which of the following describes two problems caused by poor dynamic range in a communications receiver?
- Cross-modulation of the desired signal and desensitization from strong adjacent signals
 - Oscillator instability requiring frequent retuning and loss of ability to recover the opposite sideband
 - Cross-modulation of the desired signal and insufficient audio power to operate the speaker
 - Oscillator instability and severe audio distortion of all but the strongest received signals
19. Which of the following types of receiver noise can often be reduced with a DSP noise filter?
- Broadband white noise
 - Ignition noise
 - Power line noise
 - All of these choices are correct
20. What is resonance in an electrical circuit?
- The highest frequency that will pass current
 - The lowest frequency that will pass current
 - The frequency at which the capacitive reactance equals the inductive reactance
 - The frequency at which the reactive impedance equals the resistive impedance

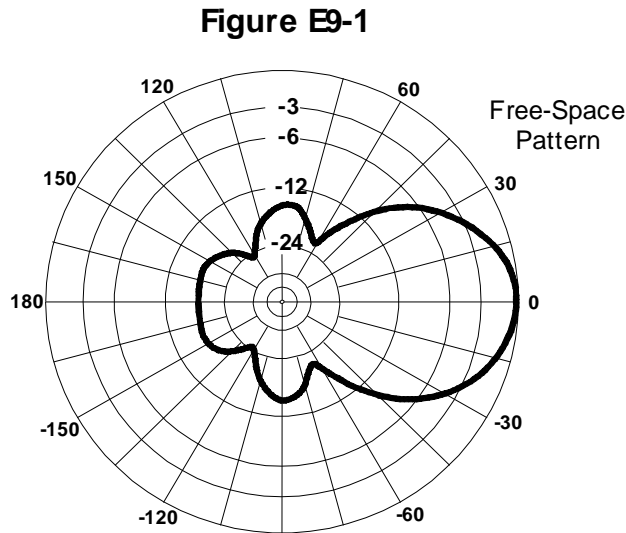
21. What is the term for the time it takes for a charged capacitor in an RC circuit to discharge to 36.8% of its initial voltage?
- One discharge period
 - An exponential discharge rate of one
 - A discharge factor of one
 - One time constant
22. How are impedances described in polar coordinates?
- By X and R values
 - By real and imaginary parts
 - By phase angle and amplitude
 - By Y and G values
23. Why is it important to keep lead lengths short for components used in circuits for VHF and above?
- To increase the thermal time constant
 - To avoid unwanted inductive reactance
 - To maintain component lifetime
 - All of these choices are correct
24. Which of the following semiconductor materials contains excess free electrons?
- N-type
 - P-type
 - Bipolar
 - Insulated gate
25. What is an important characteristic of a Schottky diode as compared to an ordinary silicon diode when used as a power supply rectifier?
- Much higher reverse voltage breakdown
 - Controlled reverse avalanche voltage
 - Enhanced carrier retention time
 - Less forward voltage drop
26. What happens when the level of a comparator's input signal crosses the threshold?
- The IC input can be damaged
 - The comparator changes its output state
 - The comparator enters latch-up
 - The feedback loop becomes unstable
27. What is the equivalent circuit of a quartz crystal?
- Motional capacitance, motional inductance, and loss resistance in series, all in parallel with a shunt capacitor representing electrode and stray capacitance
 - Motional capacitance, motional inductance, loss resistance, and a capacitor representing electrode and stray capacitance all in parallel
 - Motional capacitance, motional inductance, loss resistance, and a capacitor representing electrode and stray capacitance all in series
 - Motional inductance and loss resistance in series, paralleled with motional capacitance and a capacitor representing electrode and stray capacitance

28. Which of the following device packages is a through-hole type?
- DIP
 - PLCC
 - Ball grid array
 - SOT
29. What happens to the conductivity of a photoconductive material when light shines on it?
- It increases
 - It decreases
 - It stays the same
 - It becomes unstable
30. What is the function of a decade counter digital IC?
- It produces one output pulse for every ten input pulses
 - It decodes a decimal number for display on a seven segment LED display
 - It produces ten output pulses for every input pulse
 - It adds two decimal numbers together
31. What is a Class D amplifier?
- A type of amplifier that uses switching technology to achieve high efficiency
 - A low power amplifier that uses a differential amplifier for improved linearity
 - An amplifier that uses drift-mode FETs for high efficiency
 - A frequency doubling amplifier
32. Which of the following is a property of a T-network with series capacitors and a parallel shunt inductor?
- It is a low-pass filter
 - It is a band-pass filter
 - It is a high-pass filter
 - It is a notch filter
33. What is one characteristic of a switching electronic voltage regulator?
- The resistance of a control element is varied in direct proportion to the line voltage or load current
 - It is generally less efficient than a linear regulator
 - The controlled device's duty cycle is changed to produce a constant average output voltage
 - It gives a ramp voltage at its output
34. What is the function of a reactance modulator?
- To produce PM signals by using an electrically variable resistance
 - To produce AM signals by using an electrically variable inductance or capacitance
 - To produce AM signals by using an electrically variable resistance
 - To produce PM signals by using an electrically variable inductance or capacitance

35. What kind of digital signal processing audio filter is used to remove unwanted noise from a received SSB signal?
- An adaptive filter
 - A crystal-lattice filter
 - A Hilbert-transform filter
 - A phase-inverting filter
36. What is the effect of ringing in a filter?
- An echo caused by a long time delay
 - A reduction in high frequency response
 - Partial cancellation of the signal over a range of frequencies
 - Undesired oscillations added to the desired signal
37. Which describes a microphonic?
- An IC used for amplifying microphone signals
 - Distortion caused by RF pickup on the microphone cable
 - Changes in oscillator frequency due to mechanical vibration
 - Excess loading of the microphone by an oscillator
38. What type of wave has a rise time significantly faster than its fall time (or vice versa)?
- A cosine wave
 - A square wave
 - A sawtooth wave
 - A sine wave
39. How does the modulation index of a phase-modulated emission vary with RF carrier frequency (the modulated frequency)?
- It increases as the RF carrier frequency increases
 - It decreases as the RF carrier frequency increases
 - It varies with the square root of the RF carrier frequency
 - It does not depend on the RF carrier frequency
40. What is the definition of symbol rate in a digital transmission?
- The number of control characters in a message packet
 - The duration of each bit in a message sent over the air
 - The rate at which the waveform of a transmitted signal changes to convey information
 - The number of characters carried per second by the station-to-station link
41. What spread spectrum communications technique uses a high speed binary bit stream to shift the phase of an RF carrier?
- Frequency hopping
 - Direct sequence
 - Binary phase-shift keying
 - Phase compandored spread spectrum

42. What antenna has no gain in any direction?
- Quarter-wave vertical
 - Yagi
 - Half-wave dipole
 - Isotropic antenna

Question 43 pertains to the following graphic:



43. In the antenna radiation pattern shown in Figure E9-1, what is the front-to-back ratio?
- 36 dB
 - 18 dB
 - 24 dB
 - 14 dB
44. What is the radiation pattern of two $1/4$ wavelength vertical antennas spaced $1/4$ wavelength apart and fed 90 degrees out of phase?
- Cardioid
 - A figure-8 end-fire along the axis of the array
 - A figure-8 broadside to the axis of the array
 - Omni-directional
45. How can linearly polarized Yagi antennas be used to produce circular polarization?
- Stack two Yagis fed 90 degrees out of phase to form an array with the respective elements in parallel planes
 - Stack two Yagis fed in phase to form an array with the respective elements in parallel planes
 - Arrange two Yagis perpendicular to each other with the driven elements at the same point on the boom fed 90 degrees out of phase
 - Arrange two Yagis collinear to each other with the driven elements fed 180 degrees out of phase

46. What is the name of an antenna matching system that matches an unbalanced feed line to an antenna by feeding the driven element both at the center of the element and at a fraction of a wavelength to one side of center?
- The gamma match
 - The delta match
 - The epsilon match
 - The stub match
47. Which of the following determines the velocity factor of a transmission line?
- The termination impedance
 - The line length
 - Dielectric materials used in the line
 - The center conductor resistivity
48. What type of coordinate system is used in a Smith chart?
- Voltage circles and current arcs
 - Resistance circles and reactance arcs
 - Voltage lines and current chords
 - Resistance lines and reactance chords
49. Which is generally true for low band (160 meter and 80 meter) receiving antennas?
- Atmospheric noise is so high that gain over a dipole is not important
 - They must be erected at least $1/2$ wavelength above the ground to attain good directivity
 - Low loss coax transmission line is essential for good performance
 - All of these choices are correct
50. When evaluating RF exposure levels from your station at a neighbor's home, what must you do?
- Make sure signals from your station are less than the controlled MPE limits
 - Make sure signals from your station are less than the uncontrolled MPE limits
 - You need only evaluate exposure levels on your own property
 - Advise your neighbors of the results of your tests

Test #2 Answer Key and Explanations

1. D: The lowest frequency at which a properly adjusted LSB emission will be totally within the band is 3 kHz above the lower band edge.
2. D: If the location of an amateur station apparatus or antenna structure is of environmental importance or significant in American history, architecture, or culture, it may be restricted.
3. A: Automatic control of a station is the use of devices and procedures for control so that the control operator does not have to be present at a control point.
4. C: The amateur satellite service is a radio communications service using amateur radio stations on satellites.
5. C: The questions for all written U.S. amateur license examinations listed are in a question pool maintained by all the VECs.
6. C: Persons in the US holding an amateur service license granted by the Government of Canada are granted the operating terms and conditions of the Canadian amateur service license, not to exceed U.S. Extra Class privileges.
7. A: An amateur satellite goes from north to south in a descending pass.
8. C: There are 525 horizontal lines in a fast-scan (NTSC) television frame.
9. A: In HF contest operating, self-spotting is the generally prohibited practice of posting one's own call sign and frequency on a spotting network.
10. D: Good techniques for making meteor scatter contacts include 15 second timed transmission sequences with stations alternating based on location, use of high speed CW or digital modes, and short transmissions with rapidly repeated call signs and signal reports.
11. A: The letters FEC in digital operation mean Forward Error Correction.
12. B: A fluttery irregular fading characterizes libration fading of an EME signal.
13. C: The approximate maximum range for signals using transequatorial propagation is 5000 miles.
14. A: A rising A or K index indicates increasing disruption of the geomagnetic field.
15. B: A spectrum analyzer would display RF amplitude and frequency on the vertical and horizontal axes, respectively.
16. C: An advantage of using a bridge circuit to measure impedance is that it is very precise in obtaining a signal null.
17. A: A front-end filter or pre-selector can be effective in eliminating image signal interference.
18. A: Cross-modulation of the desired signal and desensitization from strong adjacent signals are both problems caused by poor dynamic range in a communications receiver.
19. D: Broadband white noise, ignition noise, and power line noise can often be reduced with a DSP noise filter.

20. C: Resonance in an electrical circuit is the frequency at which the capacitive reactance equals the inductive reactance.
21. D: A time-constant is the time it takes for a charged capacitor in an RC circuit to discharge to 36.8% of its initial voltage.
22. C: Impedances are described by phase angle and amplitude in polar coordinates.
23. B: It is important to keep lead lengths short for components used in circuits for VHF and above to avoid unwanted inductive reactance.
24. A: N-type semiconductor materials contain excess free electrons.
25. D: Schottky diodes can be more useful than ordinary diodes in some applications because they have less forward voltage drop.
26. B: When the level of a comparator's input signal crosses the threshold, the comparator changes its output state.
27. A: The equivalent circuit of a quartz crystal is motional capacitance, motional inductance, and loss resistance in series, all in parallel with a shunt capacitor representing electrode and stray capacitance.
28. A: DIP is a type of through-hole device packaging.
29. A: Photoconductive material becomes more conductive when light shines on it.
30. A: Decade counters produce one output pulse for every ten input pulses.
31. A: A class D amplifier uses switching technology to achieve high efficiency.
32. C: A T-network with series capacitors and a parallel shunt inductor is a high-pass filter.
33. C: A switching electronic voltage regulator changes the duty cycle of the controlled device to produce a constant average output voltage.
34. D: A reactance modulator produces PM signals by using an electrically variable inductance or capacitance.
35. A: An adaptive filter is used to remove unwanted noise from a received SSB signal.
36. D: The effect of ringing in a filter is undesired oscillations added to the desired signal.
37. C: A microphonic is a change in oscillator frequency due to mechanical vibration.
38. C: A sawtooth wave has a rise time significantly faster than its fall time (or vice versa).
39. D: The modulation index of a phase-modulated emission does not depend on the RF carrier frequency.
40. C: Symbol rate in a digital transmission is the rate at which the waveform of a transmitted signal changes to convey information.
41. B: Direct sequence uses a high speed binary bit stream to shift the phase of an RF carrier.

42. D: An isotropic antenna has no gain in any direction.
43. B: In the antenna radiation pattern shown in Figure E9-1, the front-to-back ratio is 18 dB.
44. A: The radiation pattern of two $1/4$ wavelength vertical antennas spaced $1/4$ wavelength apart and fed 90 degrees out of phase is a cardioid.
45. C: Placing two Yagis perpendicular to each other with the driven elements at the same point on the boom fed 90 degrees out of phase would result in circular polarization.
46. A: The gamma match matches an unbalanced feed line to an antenna by feeding the driven element both at the center of the element and at a fraction of a wavelength to one side of center.
47. C: The dielectric materials used determine the velocity factor of a transmission line.
48. B: Resistance circles and reactance arcs are used in Smith charts.
49. A: The gain of low band (160 meter and 80 meter) receiving antennas is not usually measured with respect to a dipole because atmospheric noise is so high.
50. B: You must make sure signals from your station are less than the uncontrolled MPE limits.

Test #3 Practice Questions

1. With your transceiver displaying the carrier frequency of phone signals, you hear a station calling CQ on 14.349 MHz USB. Is it legal to return the call using upper sideband on the same frequency?
 - a. Yes, because you were not the station calling CQ
 - b. Yes, because the displayed frequency is within the 20 meter band
 - c. No, the sideband will extend beyond the band edge
 - d. No, U.S. stations are not permitted to use phone emissions above 14.340 MHz

2. Within what distance must an amateur station protect an FCC monitoring facility from harmful interference?
 - a. 1 mile
 - b. 3 miles
 - c. 10 miles
 - d. 30 miles

3. How do the control operator responsibilities of a station under automatic control differ from one under local control?
 - a. Under local control there is no control operator
 - b. Under automatic control the control operator is not required to be present at the control point
 - c. Under automatic control there is no control operator
 - d. Under local control a control operator is not required to be present at a control point

4. What is a telecommand station in the amateur satellite service?
 - a. An amateur station located on the Earth's surface for communication with other Earth stations by means of Earth satellites
 - b. An amateur station that transmits communications to initiate, modify or terminate functions of a space station
 - c. An amateur station located more than 50 km above the Earth's surface
 - d. An amateur station that transmits telemetry consisting of measurements of upper atmosphere

5. What is a Volunteer Examiner Coordinator?
 - a. A person who has volunteered to administer amateur operator license examinations
 - b. A person who has volunteered to prepare amateur operator license examinations
 - c. An organization that has entered into an agreement with the FCC to coordinate amateur operator license examinations
 - d. The person who has entered into an agreement with the FCC to be the VE session manager

6. Under what circumstances may a dealer sell an external RF power amplifier capable of operation below 144 MHz if it has not been granted FCC certification?
 - a. It was purchased in used condition from an amateur operator and is sold to another amateur operator for use at that operator's station
 - b. The equipment dealer assembled it from a kit
 - c. It was imported from a manufacturer in a country that does not require certification of RF power amplifiers
 - d. It was imported from a manufacturer in another country and was certificated by that country's government

7. What is the orbital period of an Earth satellite?
 - a. The point of maximum height of a satellite's orbit
 - b. The point of minimum height of a satellite's orbit
 - c. The time it takes for a satellite to complete one revolution around the Earth
 - d. The time it takes for a satellite to travel from perigee to apogee
8. How is an interlaced scanning pattern generated in a fast-scan (NTSC) television system?
 - a. By scanning two fields simultaneously
 - b. By scanning each field from bottom to top
 - c. By scanning lines from left to right in one field and right to left in the next
 - d. By scanning odd numbered lines in one field and even numbered lines in the next
9. From which of the following bands is amateur radio contesting generally excluded?
 - a. 30 m
 - b. 6 m
 - c. 2 m
 - d. 33 cm
10. Which of the following digital modes is especially useful for EME communications?
 - a. FSK441
 - b. PACTOR III
 - c. Olivia
 - d. JT65
11. How is the timing of JT65 contacts organized?
 - a. By exchanging ACK/NAK packets
 - b. Stations take turns on alternate days
 - c. Alternating transmissions at 1 minute intervals
 - d. It depends on the lunar phase
12. When scheduling EME contacts, which of these conditions will generally result in the least path loss?
 - a. When the Moon is at perigee
 - b. When the Moon is full
 - c. When the Moon is at apogee
 - d. When the MUF is above 30 MHz
13. What is the best time of day for transequatorial propagation?
 - a. Morning
 - b. Noon
 - c. Afternoon or early evening
 - d. Late at night
14. Which of the following signal paths is most likely to experience high levels of absorption when the A index or K index is elevated?
 - a. Transequatorial propagation
 - b. Polar paths
 - c. Sporadic-E
 - d. NVIS

15. Which of the following test instrument is used to display spurious signals and/or intermodulation distortion products in an SSB transmitter?
- A wattmeter
 - A spectrum analyzer
 - A logic analyzer
 - A time-domain reflectometer
16. If a frequency counter with a specified accuracy of ± 1.0 ppm reads 146,520,000 Hz, what is the most the actual frequency being measured could differ from the reading?
- 165.2 Hz
 - 14.652 kHz
 - 146.52 Hz
 - 1.4652 MHz
17. What is the term for the blocking of one FM phone signal by another, stronger FM phone signal?
- Desensitization
 - Cross-modulation interference
 - Capture effect
 - Frequency discrimination
18. How can intermodulation interference between two repeaters occur?
- When the repeaters are in close proximity and the signals cause feedback in the final amplifier of one or both transmitters
 - When the repeaters are in close proximity and the signals mix in the final amplifier of one or both transmitters
 - When the signals from the transmitters are reflected out of phase from airplanes passing overhead
 - When the signals from the transmitters are reflected in phase from airplanes passing overhead
19. Which of the following signals might a receiver noise blanker be able to remove from desired signals?
- Signals which are constant at all IF levels
 - Signals which appear across a wide bandwidth
 - Signals which appear at one IF but not another
 - Signals which have a sharply peaked frequency distribution
20. What is the magnitude of the impedance of a series RLC circuit at resonance?
- High, as compared to the circuit resistance
 - Approximately equal to capacitive reactance
 - Approximately equal to inductive reactance
 - Approximately equal to circuit resistance
21. What happens to the phase angle of a reactance when it is converted to a susceptance?
- It is unchanged
 - The sign is reversed
 - It is shifted by 90 degrees
 - The susceptance phase angle is the inverse of the reactance phase angle

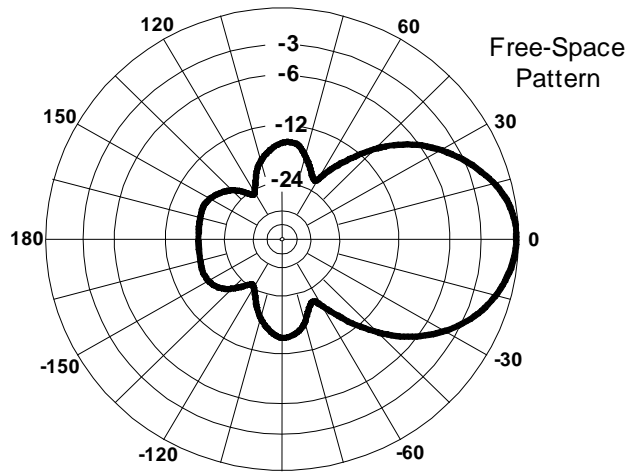
22. Which of the following represents an inductive reactance in polar coordinates?
- A positive real part
 - A negative real part
 - A positive phase angle
 - A negative phase angle
23. What is microstrip?
- Lightweight transmission line made of common zip cord
 - Miniature coax used for low power applications
 - Short lengths of coax mounted on printed circuit boards to minimize time delay between microwave circuits
 - Precision-printed circuit conductors above a ground plane that provide constant impedance interconnects at microwave frequencies
24. Why does a PN-junction diode not conduct current when reverse biased?
- Only P-type semiconductor material can conduct current
 - Only N-type semiconductor material can conduct current
 - Holes in P-type material and electrons in the N-type material are separated by the applied voltage, widening the depletion region
 - Excess holes in P-type material combine with the electrons in N-type material, converting the entire diode into an insulator
25. What special type of diode is capable of both amplification and oscillation?
- Point contact
 - Zener
 - Tunnel
 - Junction
26. What is tri-state logic?
- Logic devices with 0, 1, and high impedance output states
 - Logic devices that utilize ternary math
 - Low power logic devices designed to operate at 3 volts
 - Proprietary logic devices manufactured by Tri-State Devices
27. Which of the following is an aspect of the piezoelectric effect?
- Mechanical deformation of material by the application of a voltage
 - Mechanical deformation of material by the application of a magnetic field
 - Generation of electrical energy in the presence of light
 - Increased conductivity in the presence of light
28. Which of the following materials is likely to provide the highest frequency of operation when used in MMICs?
- Silicon
 - Silicon nitride
 - Silicon dioxide
 - Gallium nitride

29. What is the most common configuration of an optoisolator or optocoupler?
- A lens and a photomultiplier
 - A frequency modulated helium-neon laser
 - An amplitude modulated helium-neon laser
 - An LED and a phototransistor
30. Which of the following can divide the frequency of a pulse train by 2?
- An XOR gate
 - A flip-flop
 - An OR gate
 - A multiplexer
31. Which of the following components form the output of a class D amplifier circuit?
- A low-pass filter to remove switching signal components
 - A high-pass filter to compensate for low gain at low frequencies
 - A matched load resistor to prevent damage by switching transients
 - A temperature compensating load resistor to improve linearity
32. What advantage does a Pi-L-network have over a regular Pi-network for impedance matching between the final amplifier of a vacuum-tube transmitter and an antenna?
- Greater harmonic suppression
 - Higher efficiency
 - Lower losses
 - Greater transformation range
33. What device is typically used as a stable reference voltage in a linear voltage regulator?
- A Zener diode
 - A tunnel diode
 - An SCR
 - A varactor diode
34. How does an analog phase modulator function?
- By varying the tuning of a microphone preamplifier to produce PM signals
 - By varying the tuning of an amplifier tank circuit to produce AM signals
 - By varying the tuning of an amplifier tank circuit to produce PM signals
 - By varying the tuning of a microphone preamplifier to produce AM signals
35. What type of digital signal processing filter is used to generate an SSB signal?
- An adaptive filter
 - A notch filter
 - A Hilbert-transform filter
 - An elliptical filter
36. What is the typical input impedance of an integrated circuit op-amp?
- 100 ohms
 - 1000 ohms
 - Very low
 - Very high

37. How is positive feedback supplied in a Hartley oscillator?
- Through a tapped coil
 - Through a capacitive divider
 - Through link coupling
 - Through a neutralizing capacitor
38. What type of wave does a Fourier analysis show to be made up of sine waves of a given fundamental frequency plus all of its harmonics?
- A sawtooth wave
 - A square wave
 - A sine wave
 - A cosine wave
39. What is the modulation index of an FM-phone signal having a maximum frequency deviation of 3000 Hz either side of the carrier frequency when the modulating frequency is 1000 Hz?
- 3
 - 0.3
 - 3000
 - 1000
40. When performing phase shift keying, why is it advantageous to shift phase precisely at the zero crossing of the RF carrier?
- This results in the least possible transmitted bandwidth for the particular mode
 - It is easier to demodulate with a conventional, non-synchronous detector
 - It improves carrier suppression
 - All of these choices are correct
41. How does the spread spectrum technique of frequency hopping work?
- If interference is detected by the receiver it will signal the transmitter to change frequencies
 - If interference is detected by the receiver it will signal the transmitter to wait until the frequency is clear
 - A pseudo-random binary bit stream is used to shift the phase of an RF carrier very rapidly in a particular sequence
 - The frequency of the transmitted signal is changed very rapidly according to a particular sequence also used by the receiving station
42. Why would one need to know the feed point impedance of an antenna?
- To match impedances in order to minimize standing wave ratio on the transmission line
 - To measure the near-field radiation density from a transmitting antenna
 - To calculate the front-to-side ratio of the antenna
 - To calculate the front-to-back ratio of the antenna

Question 43 pertains to the following graphic:

Figure E9-1



43. In the antenna radiation pattern shown in Figure E9-1, what is the front-to-side ratio?
- a. 12 dB
 - b. 14 dB
 - c. 18 dB
 - d. 24 dB
44. What is the radiation pattern of two $1/4$ wavelength vertical antennas spaced a $1/2$ wavelength apart and fed in phase?
- a. Omni-directional
 - b. Cardioid
 - c. A Figure-8 broadside to the axis of the array
 - d. A Figure-8 end-fire along the axis of the array
45. Where should a high Q loading coil be placed to minimize losses in a shortened vertical antenna?
- a. Near the center of the vertical radiator
 - b. As low as possible on the vertical radiator
 - c. As close to the transmitter as possible
 - d. At a voltage node
46. What is the name of the matching system that uses a section of transmission line connected in parallel with the feed line at or near the feed point?
- a. The gamma match
 - b. The delta match
 - c. The omega match
 - d. The stub match

47. Why is the physical length of a coaxial cable transmission line shorter than its electrical length?
- Skin effect is less pronounced in the coaxial cable
 - The characteristic impedance is higher in a parallel feed line
 - The surge impedance is higher in a parallel feed line
 - Electrical signals move more slowly in a coaxial cable than in air
48. Which of the following is often determined using a Smith chart?
- Beam headings and radiation patterns
 - Satellite azimuth and elevation bearings
 - Impedance and SWR values in transmission lines
 - Trigonometric functions
49. What is an advantage of using a shielded loop antenna for direction finding?
- It automatically cancels ignition noise in mobile installations
 - It is electro statically balanced against ground, giving better nulls
 - It eliminates tracking errors caused by strong out-of-band signals
 - It allows stations to communicate without giving away their position
50. Which of the following would be a practical way to estimate whether the RF fields produced by an amateur radio station are within permissible MPE limits?
- Use a calibrated antenna analyzer
 - Use a hand calculator plus Smith-chart equations to calculate the fields
 - Use an antenna modeling program to calculate field strength at accessible locations
 - All of the choices are correct

Test #3 Answer Key and Explanations

1. C: It is not legal to use USB on 14.349 MHz because the sideband will extend beyond the band edge.
2. A: An amateur station located within 1 mile (1600 m) of an FCC monitoring facility must protect it from harmful interference.
3. B: The control operator does not have to be present at a station under automatic control.
4. B: A telecommand station in the amateur satellite service is an amateur station that transmits communications to initiate, modify or terminate functions of a space station.
5. C: A Volunteer Examiner Coordinator is an organization that has entered into an agreement with the FCC to coordinate amateur operator license examinations.
6. A: A dealer may sell an external RF power amplifier capable of operation below 144 MHz if it has not been granted FCC certification if it was purchased in used condition from an amateur operator and is sold to another amateur operator for use at that operator's station.
7. C: The orbital period of an Earth satellite is the time it takes for a satellite to complete one revolution around the Earth.
8. D: In a fast-scan (NTSC) television system, an interlaced scanning pattern is generated by scanning odd numbered lines in one field and even numbered lines in the next.
9. A: Amateur radio contesting is generally excluded from the 30 meter band.
10. D: The JT65 digital mode is especially useful for EME communications.
11. C: The timing of JT65 contacts is organized by alternating transmissions at 1 minute intervals.
12. A: Scheduling EME contacts when the Moon is at perigee will generally result in the least path loss.
13. C: The best time of day for transequatorial propagation is afternoon or early evening.
14. B: Polar paths are more likely to experience high levels of absorption when the A index or K index is elevated than transequatorial propagation, sporadic-E propagation, and NVIS propagation.
15. B: A spectrum analyzer is used to display spurious signals and/or intermodulation distortion products in an SSB transmitter.
16. C: The most the actual frequency being measured could differ from the reading would be 146.52 Hz.
17. C: Capture effect is the term for the blocking of one FM phone signal by another, stronger FM phone signal.
18. B: Intermodulation interference between two repeaters can occur when the repeaters are in close proximity and the signals mix in the final amplifier of one or both transmitters.
19. B: A receiver noise blanker might be able to remove signals which appear across a wide bandwidth from desired signals.

20. D: The magnitude of the impedance of a series RLC circuit at resonance is approximately equal to circuit resistance.
21. B: The sign of a phase angle of a reactance is reversed when it is converted to a susceptance.
22. C: A positive phase angle represents an inductive reactance in polar coordinates.
23. D: Microstrip is precision-printed circuit conductors above a ground plane that provide constant impedance interconnects at microwave frequencies
24. C: A PN-junction diode does not conduct current when reverse biased because holes in P-type material and electrons in the N-type material are separated by the applied voltage, widening the depletion region.
25. C: Tunnel diodes are capable of both amplification and oscillation.
26. A: Tri-state logic devices have 0, 1, and high impedance output states.
27. A: The piezoelectric effect is mechanical deformation of material by the application of a voltage.
28. D: Gallium nitride is likely to provide the highest frequency of operation when used in MMICs.
29. D: Optoisolators and optocouplers are most often used as LEDs and phototransistors, respectively.
30. B: Flip-flops can divide the frequency of a pulse train by 2.
31. A: A low-pass filter to removes switching signal components from the output of a class D amplifier.
32. A: A Pi-L-network has greater harmonic suppression than a regular Pi-network for impedance matching between the final amplifier of a vacuum-tube transmitter and an antenna.
33. A: A Zener diode is typically used as a stable reference voltage in a linear voltage regulator.
34. C: An analog phase modulator functions by varying the tuning of an amplifier tank circuit to produce PM signals.
35. C: A Hilbert-transform filter is used to generate an SSB signal.
36. D: The typical input impedance of an integrated circuit op-amp is very high.
37. A: Positive feedback is supplied through a tapped coil in a Hartley oscillator.
38. A: Fourier analysis shows sawtooth waves to be made up of sine waves of a given fundamental frequency plus all of its harmonics.
39. A: The modulation index of an FM-phone signal having a maximum frequency deviation of 3000 Hz either side of the carrier frequency when the modulating frequency is 1000 Hz is 3.
40. A: When performing phase shift keying, it is advantageous to shift phase precisely at the zero crossing of the RF carrier because it results in the least possible transmitted bandwidth for the particular mode.

41. D: In frequency hopping, the frequency of the transmitted signal is changed very rapidly according to a particular sequence also used by the receiving station.
42. A: Knowing the feed point impedance of an antenna allows one to match impedances in order to minimize standing wave ratio on the transmission line.
43. B: In the antenna radiation pattern shown in Figure E9-1, the front-to-side ratio is 14 dB.
44. C: The radiation pattern of two $1/4$ wavelength vertical antennas spaced a $1/2$ wavelength apart and fed in phase is a figure-8 broadside to the axis of the array.
45. A: A high Q loading coil should be placed near the center of the vertical radiator to minimize losses in a shortened vertical antenna.
46. D: The stub match uses a section of transmission line connected in parallel with the feed line at or near the feed point.
47. D: The physical length of a coaxial cable is shorter than its electrical length because electrical signals move more slowly in a coaxial cable than in air.
48. C: Impedance and SWR values in transmission lines are often determined using a Smith chart.
49. B: An advantage of using a shielded loop antenna for direction finding is that it is electrostatically balanced against ground, giving better nulls.
50. C: Using an antenna modeling program to calculate field strength at accessible locations is a practical way to estimate whether the RF fields produced by an amateur radio station are within permissible MPE limits.

Test #4 Practice Questions

1. With your transceiver displaying the carrier frequency of phone signals, you hear a DX station calling CQ on 3.601 MHz LSB. Is it legal to return the call using lower sideband on the same frequency?
 - a. Yes, because the DX station initiated the contact
 - b. Yes, because the displayed frequency is within the 75 meter phone band segment
 - c. No, the sideband will extend beyond the edge of the phone band segment
 - d. No, U.S. stations are not permitted to use phone emissions below 3.610 MHz

2. What must be done before placing an amateur station within an officially designated wilderness area or wildlife preserve, or an area listed in the National Register of Historical Places?
 - a. A proposal must be submitted to the National Park Service
 - b. A letter of intent must be filed with the National Audubon Society
 - c. An Environmental Assessment must be submitted to the FCC
 - d. A form FSD-15 must be submitted to the Department of the Interior

3. What is meant by IARP?
 - a. An international amateur radio permit that allows U.S. amateurs to operate in certain countries of the Americas
 - b. The internal amateur radio practices policy of the FCC
 - c. An indication of increased antenna reflected power
 - d. A forecast of intermittent aurora radio propagation

4. What is an Earth station in the amateur satellite service?
 - a. An amateur station within 50 km of the Earth's surface intended for communications with amateur stations by means of objects in space
 - b. An amateur station that is not able to communicate using amateur satellites
 - c. An amateur station that transmits telemetry consisting of measurement of upper atmosphere
 - d. Any amateur station on the surface of the Earth

5. Which of the following best describes the Volunteer Examiner accreditation process?
 - a. Each General, Advanced and Amateur Extra Class operator is automatically accredited as a VE when the license is granted
 - b. The amateur operator applying must pass a VE examination administered by the FCC Enforcement Bureau
 - c. The prospective VE obtains accreditation from the FCC
 - d. The procedure by which a VEC confirms that the VE applicant meets FCC requirements to serve as an examiner

6. Which of the following geographic descriptions approximately describes "Line A"?
 - a. A line roughly parallel to and south of the U.S.-Canadian border
 - b. A line roughly parallel to and west of the U.S. Atlantic coastline
 - c. A line roughly parallel to and north of the U.S.-Mexican border and Gulf coastline
 - d. A line roughly parallel to and east of the U.S. Pacific coastline

7. What is meant by the term mode as applied to an amateur radio satellite?
 - a. The type of signals that can be relayed through the satellite
 - b. The satellite's uplink and downlink frequency bands
 - c. The satellite's orientation with respect to the Earth
 - d. Whether the satellite is in a polar or equatorial orbit
8. What is blanking in a video signal?
 - a. Synchronization of the horizontal and vertical sync pulses
 - b. Turning off the scanning beam while it is traveling from right to left or from bottom to top
 - c. Turning off the scanning beam at the conclusion of a transmission
 - d. Transmitting a black and white test pattern
9. What type of transmission is most often used for a ham radio mesh network?
 - a. Spread spectrum in the 2.4 GHz band
 - b. Multiple Frequency Shift Keying in the 10 GHz band
 - c. Store and forward on the 440 MHz band
 - d. Frequency division multiplex in the 24 GHz band
10. What is the purpose of digital store-and-forward functions on an Amateur Radio satellite?
 - a. To upload operational software for the transponder
 - b. To delay download of telemetry between satellites
 - c. To store digital messages in the satellite for later download by other stations
 - d. To relay messages between satellites
11. What is indicated when one of the ellipses in an FSK crossed-ellipse display suddenly disappears?
 - a. Selective fading has occurred
 - b. One of the signal filters is saturated
 - c. The receiver has drifted 5 kHz from the desired receive frequency
 - d. The mark and space signal have been inverted
12. What do Hepburn maps predict?
 - a. Sporadic E propagation
 - b. Locations of auroral reflecting zones
 - c. Likelihood of rain-scatter along cold or warm fronts
 - d. Probability of tropospheric propagation
13. What is meant by the terms extraordinary and ordinary waves?
 - a. Extraordinary waves describe rare long skip propagation compared to ordinary waves which travel shorter distances
 - b. Independent waves created in the ionosphere that are elliptically polarized
 - c. Long path and short path waves
 - d. Refracted rays and reflected waves
14. What does the value of Bz (B sub Z) represent?
 - a. Geomagnetic field stability
 - b. Critical frequency for vertical transmissions
 - c. Direction and strength of the interplanetary magnetic field
 - d. Duration of long-delayed echoes

15. What determines the upper frequency limit for a computer sound-card-based oscilloscope program?
- Analog-to-digital conversion speed of the soundcard
 - Amount of memory on the soundcard
 - Q of the interface of the interface circuit
 - All of these choices are correct
16. If a frequency counter with a specified accuracy of ± 0.1 ppm reads 146,520,000 Hz, what is the most the actual frequency being measured could differ from the reading?
- 14.652 Hz
 - 0.1 MHz
 - 1.4652 Hz
 - 1.4652 kHz
17. How is the noise figure of a receiver defined?
- The ratio of atmospheric noise to phase noise
 - The ratio of the noise bandwidth in Hertz to the theoretical bandwidth of a resistive network
 - The ratio of thermal noise to atmospheric noise
 - The ratio in dB of the noise generated by the receiver to the theoretical minimum noise
18. Which of the following may reduce or eliminate intermodulation interference in a repeater caused by another transmitter operating in close proximity?
- A band-pass filter in the feed line between the transmitter and receiver
 - A properly terminated circulator at the output of the transmitter
 - A Class C final amplifier
 - A Class D final amplifier
19. How can conducted and radiated noise caused by an automobile alternator be suppressed?
- By installing filter capacitors in series with the DC power lead and a blocking capacitor in the field lead
 - By installing a noise suppression resistor and a blocking capacitor in both leads
 - By installing a high-pass filter in series with the radio's power lead and a low-pass filter in parallel with the field lead
 - By connecting the radio's power leads directly to the battery and by installing coaxial capacitors in line with the alternator leads
20. What is the magnitude of the impedance of a circuit with a resistor, an inductor and a capacitor all in parallel, at resonance?
- Approximately equal to circuit resistance
 - Approximately equal to inductive reactance
 - Low, as compared to the circuit resistance
 - Approximately equal to capacitive reactance
21. What is the time constant of a circuit having two 220 microfarad capacitors and two 1 megohm resistors, all in parallel?
- 55 seconds
 - 110 seconds
 - 440 seconds
 - 220 seconds

22. Which of the following represents a capacitive reactance in polar coordinates?
- A positive real part
 - A negative real part
 - A positive phase angle
 - A negative phase angle
23. Why are short connections necessary at microwave frequencies?
- To increase neutralizing resistance
 - To reduce phase shift along the connection
 - Because of ground reflections
 - To reduce noise figure
24. What is the name given to an impurity atom that adds holes to a semiconductor crystal structure?
- Insulator impurity
 - N-type impurity
 - Acceptor impurity
 - Donor impurity
25. What type of semiconductor device is designed for use as a voltage-controlled capacitor?
- Varactor diode
 - Tunnel diode
 - Silicon-controlled rectifier
 - Zener diode
26. What is the primary advantage of tri-state logic?
- Low power consumption
 - Ability to connect many device outputs to a common bus
 - High speed operation
 - More efficient arithmetic operations
27. Which materials are commonly used as a slug core in a variable inductor?
- Polystyrene and polyethylene
 - Ferrite and brass
 - Teflon and Delrin
 - Cobalt and aluminum
28. Which is the most common input and output impedance of circuits that use MMICs?
- 50 ohms
 - 300 ohms
 - 450 ohms
 - 10 ohms
29. What is the photovoltaic effect?
- The conversion of voltage to current when exposed to light
 - The conversion of light to electrical energy
 - The conversion of electrical energy to mechanical energy
 - The tendency of a battery to discharge when used outside

30. How many flip-flops are required to divide a signal frequency by 4?
- 1
 - 2
 - 4
 - 8
31. Where on the load line of a Class A common emitter amplifier would bias normally be set?
- Approximately half-way between saturation and cutoff
 - Where the load line intersects the voltage axis
 - At a point where the bias resistor equals the load resistor
 - At a point where the load line intersects the zero bias current curve
32. How does an impedance-matching circuit transform a complex impedance to a resistive impedance?
- It introduces negative resistance to cancel the resistive part of impedance
 - It introduces transconductance to cancel the reactive part of impedance
 - It cancels the reactive part of the impedance and changes the resistive part to a desired value
 - Network resistances are substituted for load resistances and reactances are matched to the resistances
33. Which of the following types of linear voltage regulator usually make the most efficient use of the primary power source?
- A series current source
 - A series regulator
 - A shunt regulator
 - A shunt current source
34. What is one way a single-sideband phone signal can be generated?
- By using a balanced modulator followed by a filter
 - By using a reactance modulator followed by a mixer
 - By using a loop modulator followed by a mixer
 - By driving a product detector with a DSB signal
35. What is a common method of generating an SSB signal using digital signal processing?
- Mixing products are converted to voltages and subtracted by adder circuits
 - A frequency synthesizer removes the unwanted sidebands
 - Emulation of quartz crystal filter characteristics
 - Combine signals with a quadrature phase relationship
36. What is meant by the term op-amp input offset voltage?
- The output voltage of the op-amp minus its input voltage
 - The difference between the output voltage of the op-amp and the input voltage required in the immediately following stage
 - The differential input voltage needed to bring the open loop output voltage to zero
 - The potential between the amplifier input terminals of the op-amp in an open loop condition

37. How is positive feedback supplied in a Colpitts oscillator?
- Through a tapped coil
 - Through link coupling
 - Through a capacitive divider
 - Through a neutralizing capacitor
38. What is “dither” with respect to analog to digital converters?
- An abnormal condition where the converter cannot settle on a value to represent the signal
 - A small amount of noise added to the input signal to allow more precise representation of a signal over time
 - An error caused by irregular quantization step size
 - A method of decimation by randomly skipping samples
39. What is the modulation index of an FM-phone signal having a maximum carrier deviation of plus or minus 6 kHz when modulated with a 2 kHz modulating frequency?
- 6000
 - 3
 - 2000
 - 1/3
40. What technique is used to minimize the bandwidth requirements of a PSK31 signal?
- Zero-sum character encoding
 - Reed-Solomon character encoding
 - Use of sinusoidal data pulses
 - Use of trapezoidal data pulses
41. What is the primary effect of extremely short rise or fall time on a CW signal?
- More difficult to copy
 - The generation of RF harmonics
 - The generation of key clicks
 - Limits data speed
42. Which of the following factors may affect the feed point impedance of an antenna?
- Transmission-line length
 - Antenna height, conductor length/diameter ratio and location of nearby conductive objects
 - The settings of an antenna tuner at the transmitter
 - Sunspot activity and time of day
43. What may occur when a directional antenna is operated at different frequencies within the band for which it was designed?
- Feed point impedance may become negative
 - The E-field and H-field patterns may reverse
 - Element spacing limits could be exceeded
 - The gain may change depending on frequency

44. What happens to the radiation pattern of an unterminated long wire antenna as the wire length is increased?
- The lobes become more perpendicular to the wire
 - The lobes align more in the direction of the wire
 - The vertical angle increases
 - The front-to-back ratio decreases
45. Why should an HF mobile antenna loading coil have a high ratio of reactance to resistance?
- To swamp out harmonics
 - To maximize losses
 - To minimize losses
 - To minimize the Q
46. What is the purpose of the series capacitor in a gamma-type antenna matching network?
- To provide DC isolation between the feed line and the antenna
 - To cancel the inductive reactance of the matching network
 - To provide a rejection notch that prevents the radiation of harmonics
 - To transform the antenna impedance to a higher value
47. What is the typical velocity factor for a coaxial cable with solid polyethylene dielectric?
- 2.70
 - 0.66
 - 0.30
 - 0.10
48. What are the two families of circles and arcs that make up a Smith chart?
- Resistance and voltage
 - Reactance and voltage
 - Resistance and reactance
 - Voltage and impedance
49. What is the main drawback of a wire-loop antenna for direction finding?
- It has a bidirectional pattern
 - It is non-rotatable
 - It receives equally well in all directions
 - It is practical for use only on VHF bands
50. When evaluating a site with multiple transmitters operating at the same time, the operators and licensees of which transmitters are responsible for mitigating over-exposure situations?
- Only the most powerful transmitter
 - Only commercial transmitters
 - Each transmitter that produces 5 percent or more of its MPE limit at accessible locations
 - Each transmitter operating with a duty-cycle greater than 50 percent

Test #4 Answer Key and Explanations

1. C: It is not legal to respond using LSB on 3.601 MHz because the sideband will extend beyond the edge of the phone band segment.
2. C: Before placing an amateur station within an officially designated wilderness area or wildlife preserve, or an area listed in the National Register of Historical Places, an Environmental Assessment must be submitted to the FCC.
3. A: IARP is an international amateur radio permit that allows U.S. amateurs to operate in certain countries of the Americas.
4. A: An Earth station in the amateur satellite service is an amateur station within 50 km of the Earth's surface intended for communications with amateur stations by means of objects in space.
5. D: The Volunteer Examiner accreditation process is the procedure by which a VEC confirms that the VE applicant meets FCC requirements to serve as an examiner.
6. A: "Line A" is a line roughly parallel to and south of the U.S.-Canadian border.
7. B: The term mode as applied to an amateur radio satellite refers to the satellite's uplink and downlink frequency bands.
8. B: Blanking in a video signal is turning off the scanning beam while it is traveling from right to left or from bottom to top.
9. A: Spread spectrum in the 2.4 GHz band is most often used for a ham radio mesh network.
10. C: The purpose of digital store-and-forward functions on an Amateur Radio satellite is to store digital messages in the satellite for later download by other stations.
11. A: When one of the ellipses in an FSK crossed-ellipse display suddenly disappears, it means selective fading has occurred.
12. D: Hepburn maps predict the probability of tropospheric propagation.
13. B: Extraordinary and ordinary waves are independent waves created in the ionosphere that are elliptically polarized.
14. C: B_z represents the direction and strength of the interplanetary magnetic field.
15. A: The analog-to-digital conversion speed of the sound card determines the upper frequency limit of a computer sound-card-based oscilloscope program.
16. A: The most the actual frequency being measured could differ from the reading would be 14.652 Hz.
17. D: The noise figure of a receiver is defined as the ratio in dB of the noise generated by the receiver to the theoretical minimum noise.
18. B: A properly terminated circulator at the output of the transmitter may reduce or eliminate intermodulation interference in a repeater caused by another transmitter operating in close proximity.

19. D: Conducted and radiated noise caused by an automobile alternator can be suppressed by connecting the radio's power leads directly to the battery and by installing coaxial capacitors in line with the alternator leads.
20. A: The magnitude of the impedance of a circuit with a resistor, an inductor and a capacitor all in parallel, at resonance is approximately equal to circuit resistance.
21. D: The time constant of a circuit having two 220 microfarad capacitors and two 1 megohm resistors, all in parallel, is 220 seconds.
22. D: A negative phase angle represents a capacitive reactance in polar coordinates.
23. B: Short connections are necessary at microwave frequencies to reduce phase shift along the connection.
24. C: Acceptor impurities are atoms that add holes to a semiconductor crystal structure.
25. A: Varactor diode are designed for use as voltage-controlled capacitors.
26. B: The primary advantage of tri-state logic is the ability to connect many device outputs to a common bus.
27. B: Ferrite and brass are commonly used as slug cores in variable inductors.
28. A: 50 ohms is the most common input and output impedance of circuits that use MMICs.
29. B: The photovoltaic effect is the conversion of light to electrical energy.
30. B: Two flip-flops are required to divide a signal frequency by 4.
31. A: Bias would normally be set approximately half-way between saturation and cutoff for a class A common emitter amplifier.
32. C: An impedance-matching circuit cancels the reactive part of the impedance and changes the resistive part to a desired value.
33. B: A series linear voltage regulator usually makes the most efficient use of the primary power source.
34. A: A single-sideband phone signal can be generated by using a balanced modulator followed by a filter.
35. D: Combining signals with a quadrature phase relationship is a common method of generating an SSB signal.
36. C: Op-amp input offset voltage is the differential input voltage needed to bring the open loop output voltage to zero.
37. C: Positive feedback is supplied through a capacitive divider in a Colpitts oscillator.
38. B: "Dither" in analog to digital converters is a small amount of noise added to the input signal to allow more precise representation of a signal over time.

39. B: The modulation index of an FM-phone signal having a maximum carrier deviation of plus or minus 6 kHz when modulated with a 2 kHz modulating frequency is 3.
40. C: Use of sinusoidal data pulses helps minimize the bandwidth requirements of a PSK31 signal.
41. C: Extremely short rise or fall time on a CW signal lead to the generation of key clicks.
42. B: Antenna height, conductor length/diameter ratio and location of nearby conductive objects may affect the feed point impedance of an antenna.
43. D: The gain may change depending on frequency if a directional antenna is operated at different frequencies within the band for which it was designed.
44. B: The lobes of the radiation pattern align more in the direction of the wire as wire length is increased.
45. C: An HF mobile antenna loading coil should have a high ratio of reactance to resistance to minimize losses.
46. B: The series capacitor in a gamma-type antenna matching network serves to cancel the inductive reactance of the matching network.
47. B: Coaxial cables with solid polyethylene dielectrics usually have a velocity factor of 0.66.
48. C: Resistance and reactance are the two families of circles and arcs that make up a Smith chart.
49. A: The main drawback of a wire-loop antenna for direction finding is that it has a bidirectional pattern.
50. C: When evaluating a site with multiple transmitters operating at the same time, the operators and licensees of each transmitter that produces 5 percent or more of its MPE limit at accessible locations are responsible for mitigating over-exposure situations.

Test #5 Practice Questions

1. What is the maximum power output permitted on the 60-meter band?
 - a. 50 watts PEP effective radiated power relative to an isotropic radiator
 - b. 50 watts PEP effective radiated power relative to a dipole
 - c. 100 watts PEP effective radiated power relative to the gain of a half-wave dipole
 - d. 100 watts PEP effective radiated power relative to an isotropic radiator
2. What is the National Radio Quiet Zone?
 - a. An area in Puerto Rico surrounding the Arecibo Radio Telescope
 - b. An area in New Mexico surrounding the White Sands Test Area
 - c. An area surrounding the National Radio Astronomy Observatory
 - d. An area in Florida surrounding Cape Canaveral
3. When may an automatically controlled station originate third party communications?
 - a. Never
 - b. Only when transmitting RTTY or data emissions
 - c. When agreed upon by the sending or receiving station
 - d. When approved by the National Telecommunication and Information Administration
4. What class of licensee is authorized to be the control operator of a space station?
 - a. All except Technician Class
 - b. Only General, Advanced or Amateur Extra Class
 - c. Any class with appropriate operator privileges
 - d. Only Amateur Extra Class
5. What is the minimum passing score on amateur operator license examinations?
 - a. Minimum passing score of 70%
 - b. Minimum passing score of 74%
 - c. Minimum passing score of 80%
 - d. Minimum passing score of 77%
6. Amateur stations may not transmit in which of the following frequency segments if they are located in the contiguous 48 states and north of Line A?
 - a. 440 MHz – 450 MHz
 - b. 53 MHz – 54 MHz
 - c. 222 MHz – 223 MHz
 - d. 420 MHz – 430 MHz
7. What do the letters in a satellite's mode designator specify?
 - a. Power limits for uplink and downlink transmissions
 - b. The location of the ground control station
 - c. The polarization of uplink and downlink signals
 - d. The uplink and downlink frequency ranges

8. Which of the following is an advantage of using vestigial sideband for standard fast-scan TV transmissions?
- The vestigial sideband carries the audio information
 - The vestigial sideband contains chroma information
 - Vestigial sideband reduces bandwidth while allowing for simple video detector circuitry
 - Vestigial sideband provides high frequency emphasis to sharpen the picture
9. What is the function of a DX QSL Manager?
- To allocate frequencies for DXpeditions
 - To handle the receiving and sending of confirmation cards for a DX station
 - To run a net to allow many stations to contact a rare DX station
 - To relay calls to and from a DX station
10. Which of the following techniques is normally used by low Earth orbiting digital satellites to relay messages around the world?
- Digipeating
 - Store-and-forward
 - Multi-satellite relaying
 - Node hopping
11. Which type of digital mode does not support keyboard-to-keyboard operation?
- Winlink
 - RTTY
 - PSK31
 - MFSK
12. Tropospheric propagation of microwave signals often occurs along what weather-related structure?
- Gray-line
 - Lightning discharges
 - Warm and cold fronts
 - Sprites and jets
13. Which amateur bands typically support long-path propagation?
- 160 meters to 40 meters
 - 30 meters to 10 meters
 - 160 meters to 10 meters
 - 6 meters to 2 meters
14. What orientation of B_z ($B_{sub\ z}$) increases the likelihood that incoming particles from the Sun will cause disturbed conditions?
- Southward
 - Northward
 - Eastward
 - Westward

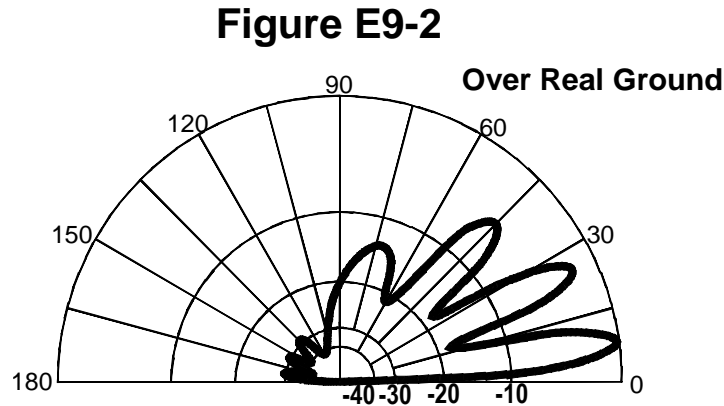
15. What might be an advantage of a digital vs. an analog oscilloscope?
- Automatic amplitude and frequency numerical readout
 - Storage of traces for future reference
 - Manipulation of time base after trace capture
 - All of these choices are correct
16. If a frequency counter with a specified accuracy of ± 10 ppm reads 146,520,000 Hz, what is the most the actual frequency being measured could differ from the reading?
- 146.52 Hz
 - 10 Hz
 - 146.52 kHz
 - 1465.20 Hz
17. What does a value of -174 dBm/Hz represent with regard to the noise floor of a receiver?
- The minimum detectable signal as a function of receive frequency
 - The theoretical noise at the input of a perfect receiver at room temperature
 - The noise figure of a 1 Hz bandwidth receiver
 - The galactic noise contribution to minimum detectable signal
18. What transmitter frequencies would cause an intermodulation-product signal in a receiver tuned to 146.70 MHz when a nearby station transmits on 146.52 MHz?
- 146.34 MHz and 146.61 MHz
 - 146.88 MHz and 146.34 MHz
 - 146.10 MHz and 147.30 MHz
 - 173.35 MHz and 139.40 MHz
19. How can noise from an electric motor be suppressed?
- By installing a high pass filter in series with the motor's power leads
 - By installing a brute-force AC-line filter in series with the motor leads
 - By installing a bypass capacitor in series with the motor leads
 - By using a ground-fault current interrupter in the circuit used to power the motor
20. What is the magnitude of the current at the input of a series RLC circuit as the frequency goes through resonance?
- Minimum
 - Maximum
 - R/L
 - L/R
21. What happens to the magnitude of a reactance when it is converted to a susceptance?
- It is unchanged
 - The sign is reversed
 - It is shifted by 90 degrees
 - The magnitude of the susceptance is the reciprocal of the magnitude of the reactance

22. What is the name of the diagram used to show the phase relationship between impedances at a given frequency?
- Venn diagram
 - Near field diagram
 - Phasor diagram
 - Far field diagram
23. Which parasitic characteristic increases with conductor length?
- Inductance
 - Permeability
 - Permittivity
 - Malleability
24. What is the alpha of a bipolar junction transistor?
- The change of collector current with respect to base current
 - The change of base current with respect to collector current
 - The change of collector current with respect to emitter current
 - The change of collector current with respect to gate current
25. What characteristic of a PIN diode makes it useful as an RF switch or attenuator?
- Extremely high reverse breakdown voltage
 - Ability to dissipate large amounts of power
 - Reverse bias controls its forward voltage drop
 - A large region of intrinsic material
26. What is an advantage of CMOS logic devices over TTL devices?
- Differential output capability
 - Lower distortion
 - Immune to damage from static discharge
 - Lower power consumption
27. What is one reason for using ferrite cores rather than powdered-iron in an inductor?
- Ferrite toroids generally have lower initial permeability
 - Ferrite toroids generally have better temperature stability
 - Ferrite toroids generally require fewer turns to produce a given inductance value
 - Ferrite toroids are easier to use with surface mount technology
28. Which of the following noise figure values is typical of a low-noise UHF preamplifier?
- 2 dB
 - 10 dB
 - 44 dBm
 - 20 dBm
29. Which describes an optical shaft encoder?
- A device which detects rotation of a control by interrupting a light source with a patterned wheel
 - A device which measures the strength of a beam of light using analog to digital conversion
 - A digital encryption device often used to encrypt spacecraft control signals
 - A device for generating RTTY signals by means of a rotating light source

30. Which of the following is a circuit that continuously alternates between two states without an external clock?
- Monostable multivibrator
 - J-K flip-flop
 - T flip-flop
 - Astable multivibrator
31. What can be done to prevent unwanted oscillations in an RF power amplifier?
- Tune the stage for maximum SWR
 - Tune both the input and output for maximum power
 - Install parasitic suppressors and/or neutralize the stage
 - Use a phase inverter in the output filter
32. Which filter type is described as having ripple in the passband and a sharp cutoff?
- A Butterworth filter
 - An active LC filter
 - A passive op-amp filter
 - A Chebyshev filter
33. Which of the following types of linear voltage regulator places a constant load on the unregulated voltage source?
- A constant current source
 - A series regulator
 - A shunt current source
 - A shunt regulator
34. What circuit is added to an FM transmitter to boost the higher audio frequencies?
- A de-emphasis network
 - A heterodyne suppressor
 - An audio prescaler
 - A pre-emphasis network
35. How frequently must an analog signal be sampled by an analog-to-digital converter so that the signal can be accurately reproduced?
- At half the rate of the highest frequency component of the signal
 - At twice the rate of the highest frequency component of the signal
 - At the same rate as the highest frequency component of the signal
 - At four times the rate of the highest frequency component of the signal
36. How can unwanted ringing and audio instability be prevented in a multi-section op-amp RC audio filter circuit?
- Restrict both gain and Q
 - Restrict gain but increase Q
 - Restrict Q but increase gain
 - Increase both gain and Q

37. How is positive feedback supplied in a Pierce oscillator?
- Through a tapped coil
 - Through link coupling
 - Through a neutralizing capacitor
 - Through a quartz crystal
38. What would be the most accurate way of measuring the RMS voltage of a complex waveform?
- By using a grid dip meter
 - By measuring the voltage with a D'Arsonval meter
 - By using an absorption wave meter
 - By measuring the heating effect in a known resistor
39. What is the deviation ratio of an FM-phone signal having a maximum frequency swing of plus-or-minus 5 kHz when the maximum modulation frequency is 3 kHz?
- 60
 - 0.167
 - 0.6
 - 1.67
40. What is the necessary bandwidth of a 13-WPM international Morse code transmission?
- Approximately 13 Hz
 - Approximately 26 Hz
 - Approximately 52 Hz
 - Approximately 104 Hz
41. What is the most common method of reducing key clicks?
- Increase keying waveform rise and fall times
 - Low-pass filters at the transmitter output
 - Reduce keying waveform rise and fall times
 - High-pass filters at the transmitter output
42. What is included in the total resistance of an antenna system?
- Radiation resistance plus space impedance
 - Radiation resistance plus transmission resistance
 - Transmission-line resistance plus radiation resistance
 - Radiation resistance plus ohmic resistance

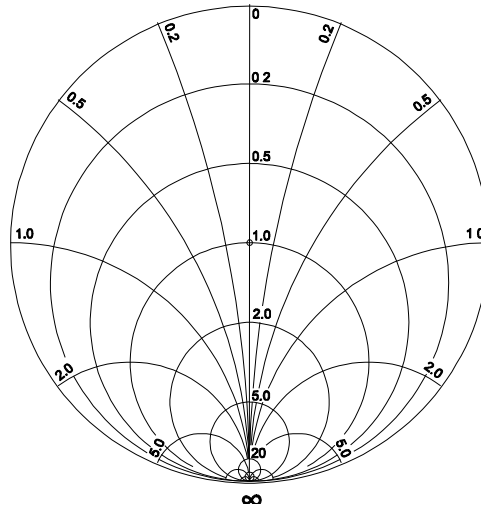
Question 43 pertains to the following graphic:



43. What type of antenna pattern over real ground is shown in Figure E9-2?
- Elevation
 - Azimuth
 - Radiation resistance
 - Polarization
44. What is an OCFD antenna?
- A dipole feed approximately 1/3 the way from one end with a 4:1 balun to provide multiband operation
 - A remotely tunable dipole antenna using orthogonally controlled frequency diversity
 - An eight band dipole antenna using octophase filters
 - A multiband dipole antenna using one-way circular polarization for frequency diversity
45. What is a disadvantage of using a multiband trapped antenna?
- It might radiate harmonics
 - It radiates the harmonics and fundamental equally well
 - It is too sharply directional at lower frequencies
 - It must be neutralized
46. How must the driven element in a 3-element Yagi be tuned to use a hairpin matching system?
- The driven element reactance must be capacitive
 - The driven element reactance must be inductive
 - The driven element resonance must be lower than the operating frequency
 - The driven element radiation resistance must be higher than the characteristic impedance of the transmission line
47. What is the approximate physical length of a solid polyethylene dielectric coaxial transmission line that is electrically one-quarter wavelength long at 14.1 MHz?
- 20 meters
 - 2.3 meters
 - 3.5 meters
 - 0.2 meters

Question 48 pertains to the following graphic:

Figure E9-3



48. What type of chart is shown in Figure E9-3?
- Smith chart
 - Free space radiation directivity chart
 - Elevation angle radiation pattern chart
 - Azimuth angle radiation pattern chart
49. What is the triangulation method of direction finding?
- The geometric angles of sky waves from the source are used to determine its position
 - A fixed receiving station plots three headings to the signal source
 - Antenna headings from several different receiving locations are used to locate the signal source
 - A fixed receiving station uses three different antennas to plot the location of the signal source
50. What is one of the potential hazards of using microwaves in the amateur radio bands?
- Microwaves are ionizing radiation
 - The high gain antennas commonly used can result in high exposure levels
 - Microwaves often travel long distances by ionospheric reflection
 - The extremely high frequency energy can damage the joints of antenna structures

Test #5 Answer Key and Explanations

1. C: The maximum power output permitted on the 60-meter band is 100 W PEP relative to a half-wave dipole. Before March 3, 2012, the maximum was 50 W.
2. C: The National Radio Quiet Zone is an area surrounding the National Radio Astronomy Observatory.
3. A: An automatically controlled station may never originate third party communications.
4. C: Any license class with appropriate operator privileges is authorized to be the control operator of a space station.
5. B: The minimum passing score on amateur operator license examinations is 74%.
6. D: Amateur stations may not transmit on frequencies between 222 MHz and 223 MHz if they are located in the contiguous 48 states and north of Line A.
7. D: The letters in a satellite's mode designator specify the uplink and downlink frequency ranges.
8. C: An advantage of using vestigial sideband for standard fast-scan TV transmissions is reducing bandwidth while allowing for simple video detector circuitry.
9. B: A DX QSL Manager handles the receiving and sending of confirmation cards for a DX station.
10. B: Store-and-forward is a technique used by low Earth orbiting digital satellites to relay messages around the world.
11. A: Winlink does not support keyboard-to-keyboard operation.
12. C: Tropospheric propagation of microwave signals often occurs along warm and cold fronts.
13. C: The amateur 160 m and 10 m bands typically support long-path propagation.
14. A: A southward orientation of Bz increases the likelihood that incoming particles from the Sun will cause disturbed conditions.
15. D: Digital oscilloscopes have many advantages over analog oscilloscopes, including automatic amplitude and frequency readouts, onboard storage of traces, and manipulation of time bases after trace capture.
16. D: The most the actual frequency being measured could differ from the reading would be 1465.20 Hz.
17. B: A value of -174 dBm/Hz represents the theoretical noise at the input of a perfect receiver at room temperature.
18. A: 146.34 MHz and 146.61 MHz frequencies would cause an intermodulation-product signal in a receiver tuned to 146.70 MHz when a nearby station transmits on 146.52 MHz.
19. B: Noise from an electric motor can be suppressed by installing a brute-force AC-line filter in series with the motor leads.

20. B: The magnitude of the current at the input of a series RLC circuit as the frequency goes through resonance is at maximum.
21. D: When a reactance is converted to a susceptance, the magnitude of the susceptance is the reciprocal of the magnitude of the reactance.
22. C: A phasor diagram is used to show the phase relationship between impedances at a given frequency.
23. A: Inductance increases with conductor length.
24. C: The alpha of a bipolar junction transistor is the change in collector current with respect to emitter current.
25. D: The large region of intrinsic material in a PIN diode makes it useful as an RF switch or attenuator.
26. D: An advantage of CMOS logic devices over TTL devices is lower power consumption.
27. C: Ferrite toroids generally require fewer turns than powdered-iron to produce a given inductance value.
28. A: 2 dB is a typical noise value of a low-noise UHF preamplifier.
29. A: An optical shaft encoder is a device which detects rotation of a control by interrupting a light source with a patterned wheel.
30. D: Astable multivibrators continuously alternate between two states without an external clock.
31. C: Installing parasitic suppressors and/or neutralizing the stage can prevent unwanted oscillations in an RF power amplifier.
32. D: A Chebyshev filter is described as having ripple in the passband and a sharp cutoff.
33. D: A shunt regulator places a constant load on the unregulated voltage source.
34. D: A pre-emphasis network can be added to an FM transmitter to boost the higher audio frequencies.
35. B: An analog signal be sampled at twice the rate of the highest frequency component of the signal by an analog-to-digital converter.
36. A: Ringing and audio instability be prevented in a multi-section op-amp RC audio filter circuit by restricting both gain and Q.
37. D: Positive feedback is supplied through a quartz crystal in a Pierce oscillator.
38. D: The most accurate way of measuring the RMS voltage of a complex waveform would be measuring the heating effect in a known resistor.
39. D: The deviation ratio of an FM-phone signal having a maximum frequency swing of plus-or-minus 5 kHz when the maximum modulation frequency is 3 kHz is 1.67.

40. C: A 13-WPM international Morse code transmission requires a bandwidth of approximately 52 Hz.
41. A: The most common method of reducing key clicks is increasing keying waveform rise and fall times.
42. D: Radiation resistance plus ohmic resistance is included in the total resistance of an antenna system.
43. A: An elevation antenna pattern over real ground is shown in Figure E9-2.
44. A: An OCFD antenna is a dipole feed approximately 1/3 the way from one end with a 4:1 balun to provide multiband operation.
45. A: A disadvantage of using a multiband trapped antenna is that it might radiate harmonics.
46. A: The driven element in a 3-element Yagi must be tuned to have capacitive reactance to use a hairpin matching system.
47. C: A solid polyethylene dielectric coaxial transmission line that is electrically one-quarter wavelength long at 14.1 MHz has an approximate physical length of 3.5 meters.
48. A: A Smith chart is shown in Figure E9-3.
49. C: The triangulation method of direction finding involves using antenna headings from several different receiving locations to locate the signal source.
50. B: One of the potential hazards of using microwaves in the amateur radio bands is that the high gain antennas commonly used can result in high exposure levels.

Test #6 Practice Questions

1. Where must the carrier frequency of a CW signal be set to comply with FCC rules for 60-meter operation?
 - a. At the lowest frequency of the channel
 - b. At the center frequency of the channel
 - c. At the highest frequency of the channel
 - d. On any frequency where the signal's sidebands are within the channel

2. Which of the following additional rules apply if you are installing an amateur station antenna at a site at or near a public use airport?
 - a. You may have to notify the Federal Aviation Administration and register it with the FCC as required by Part 17 of FCC rules
 - b. No special rules apply if your antenna structure will be less than 300 feet in height
 - c. You must file an Environmental Impact Statement with the EPA before construction begins
 - d. You must obtain a construction permit from the airport zoning authority

3. Which of the following statements concerning remotely controlled amateur stations is true?
 - a. Only Extra Class operators may be the control operator of a remote station
 - b. A control operator need not be present at the control point
 - c. A control operator must be present at the control point
 - d. Repeater and auxiliary stations may not be remotely controlled

4. Which of the following is a requirement of a space station?
 - a. The space station must be capable of terminating transmissions by telecommand when directed by the FCC
 - b. The space station must cease all transmissions after 5 years
 - c. The space station must be capable of changing its orbit whenever such a change is ordered by NASA
 - d. All of these choices are correct

5. Who is responsible for the proper conduct and necessary supervision during an amateur operator license examination session?
 - a. The VEC coordinating the session
 - b. The FCC
 - c. Each administering VE
 - d. The VE session manager

6. Under what circumstances might the FCC issue a Special Temporary Authority (STA) to an amateur station?
 - a. To provide for experimental amateur communications
 - b. To allow regular operation on Land Mobile channels
 - c. To provide additional spectrum for personal use
 - d. To provide temporary operation while awaiting normal licensing

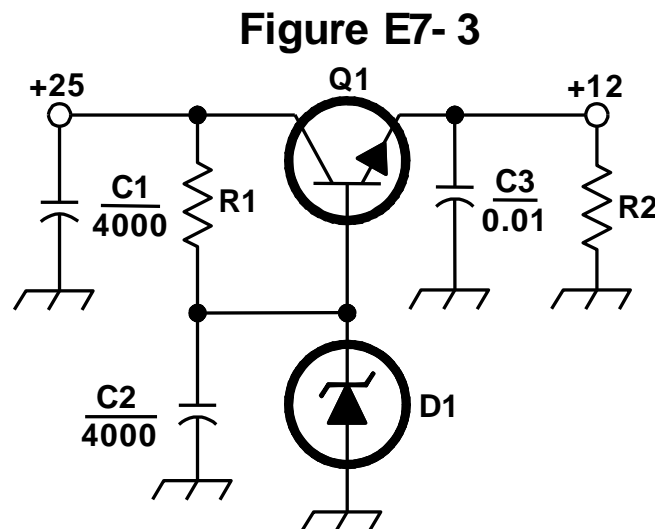
7. On what band would a satellite receive signals if it were operating in mode U/V?
- 435 MHz – 438 MHz
 - 144 MHz – 146 MHz
 - 50.0 MHz – 50.2 MHz
 - 29.5 MHz – 29.7 MHz
8. What is vestigial sideband modulation?
- Amplitude modulation in which one complete sideband and a portion of the other are transmitted
 - A type of modulation in which one sideband is inverted
 - Narrow-band FM modulation achieved by filtering one sideband from the audio before frequency modulating the carrier
 - Spread spectrum modulation achieved by applying FM modulation following single sideband amplitude modulation
9. During a VHF/UHF contest, in which band segment would you expect to find the highest level of activity?
- At the top of each band, usually in a segment reserved for contests
 - In the middle of each band, usually on the national calling frequency
 - In the weak signal segment of the band, with most of the activity near the calling frequency
 - In the middle of the band, usually 25 kHz above the national calling frequency
10. Which of the following describes a method of establishing EME contacts?
- Time synchronous transmissions alternately from each station
 - Storing and forwarding digital messages
 - Judging optimum transmission times by monitoring beacons reflected from the Moon
 - High speed CW identification to avoid fading
11. What is the most common data rate used for HF packet?
- 48 baud
 - 110 baud
 - 300 baud
 - 1200 baud
12. Which of the following is required for microwave propagation via rain scatter?
- Rain droplets must be electrically charged
 - Rain droplets must be within the E layer
 - The rain must be within radio range of both stations
 - All of these choices are correct
13. Which of the following amateur bands most frequently provides long-path propagation?
- 80 meters
 - 20 meters
 - 10 meters
 - 6 meters

14. By how much does the VHF/UHF radio horizon distance exceed the geometric horizon?
- By approximately 15 percent of the distance
 - By approximately twice the distance
 - By approximately 50 percent of the distance
 - By approximately four times the distance
15. What is the effect of aliasing in a digital or computer-based oscilloscope?
- False signals are displayed
 - All signals will have a DC offset
 - Calibration of the vertical scale is no longer valid
 - False triggering occurs
16. How much power is being absorbed by the load when a directional power meter connected between a transmitter and a terminating load reads 100 watts forward power and 25 watts reflected power?
- 100 watts
 - 125 watts
 - 25 watts
 - 75 watts
17. A CW receiver with the AGC off has an equivalent input noise power density of -174 dBm/Hz. What would be the level of an unmodulated carrier input to this receiver that would yield an audio output SNR of 0 dB in a 400 Hz noise bandwidth?
- 174 dBm
 - 164 dBm
 - 155 dBm
 - 148 dBm
18. What is the term for unwanted signals generated by the mixing of two or more signals?
- Amplifier desensitization
 - Neutralization
 - Adjacent channel interference
 - Intermodulation interference
19. What is a major cause of atmospheric static?
- Solar radio frequency emissions
 - Thunderstorms
 - Geomagnetic storms
 - Meteor showers
20. What is the magnitude of the circulating current within the components of a parallel LC circuit at resonance?
- It is at a minimum
 - It is at a maximum
 - It equals 1 divided by the quantity 2 times Pi, multiplied by the square root of inductance L multiplied by capacitance C
 - It equals 2 multiplied by Pi, multiplied by frequency, multiplied by inductance

21. What is susceptance?
- The magnetic impedance of a circuit
 - The ratio of magnetic field to electric field
 - The inverse of reactance
 - A measure of the efficiency of a transformer
22. What does the impedance $50-j25$ represent?
- 50 ohms resistance in series with 25 ohms inductive reactance
 - 50 ohms resistance in series with 25 ohms capacitive reactance
 - 25 ohms resistance in series with 50 ohms inductive reactance
 - 25 ohms resistance in series with 50 ohms capacitive reactance
23. In what direction is the magnetic field oriented about a conductor in relation to the direction of electron flow?
- In the same direction as the current
 - In a direction opposite to the current
 - In all directions; omni-directional
 - In a direction determined by the left-hand rule
24. What is the beta of a bipolar junction transistor?
- The frequency at which the current gain is reduced to 1
 - The change in collector current with respect to base current
 - The breakdown voltage of the base to collector junction
 - The switching speed of the transistor
25. Which of the following is a common use of a hot-carrier diode?
- As balanced mixers in FM generation
 - As a variable capacitance in an automatic frequency control circuit
 - As a constant voltage reference in a power supply
 - As a VHF/UHF mixer or detector
26. Why do CMOS digital integrated circuits have high immunity to noise on the input signal or power supply?
- Larger bypass capacitors are used in CMOS circuit design
 - The input switching threshold is about two times the power supply voltage
 - The input switching threshold is about one-half the power supply voltage
 - Input signals are stronger
27. What core material property determines the inductance of a toroidal inductor?
- Thermal impedance
 - Resistance
 - Reactivity
 - Permeability

28. What characteristics of the MMIC make it a popular choice for VHF through microwave circuits?
- The ability to retrieve information from a single signal even in the presence of other strong signals
 - Plate current that is controlled by a control grid
 - Nearly infinite gain, very high input impedance, and very low output impedance
 - Controlled gain, low noise figure, and constant input and output impedance over the specified frequency range
29. Which of these materials is affected the most by photoconductivity?
- A crystalline semiconductor
 - An ordinary metal
 - A heavy metal
 - A liquid semiconductor
30. What is a characteristic of a monostable multivibrator?
- It switches momentarily to the opposite binary state and then returns to its original state after a set time
 - It produces a continuous square wave oscillating between 1 and 0
 - It stores one bit of data in either a 0 or 1 state
 - It maintains a constant output voltage, regardless of variations in the input voltage
31. Which of the following amplifier types reduces or eliminates even order harmonics?
- Push-push
 - Push-pull
 - Class C
 - Class AB
32. What are the distinguishing features of an elliptical filter?
- Gradual passband rolloff with minimal stop band ripple
 - Extremely flat response over its pass band with gradually rounded stop band corners
 - Extremely sharp cutoff with one or more notches in the stop band
 - Gradual passband rolloff with extreme stop band ripple

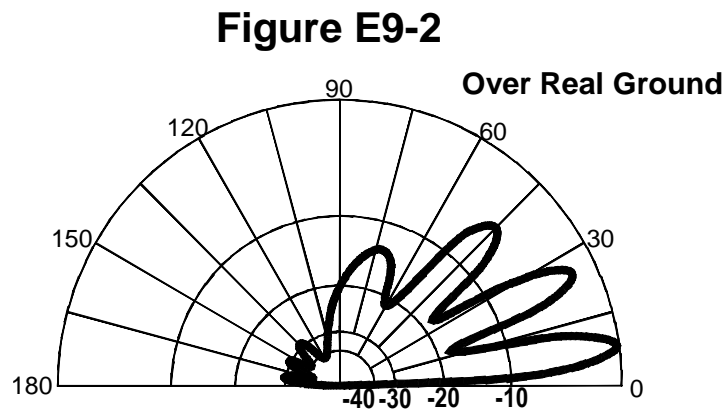
Question 33 pertains to the following graphic:



33. What is the purpose of Q1 in the circuit shown in Figure E7-3?
- It provides negative feedback to improve regulation
 - It provides a constant load for the voltage source
 - It increases the current-handling capability of the regulator
 - It provides D1 with current
34. Why is de-emphasis commonly used in FM communications receivers?
- For compatibility with transmitters using phase modulation
 - To reduce impulse noise reception
 - For higher efficiency
 - To remove third-order distortion products
35. What is the minimum number of bits required for an analog-to-digital converter to sample a signal with a range of 1 volt at a resolution of 1 millivolt?
- 4 bits
 - 6 bits
 - 8 bits
 - 10 bits
36. Which of the following is the most appropriate use of an op-amp active filter?
- As a high-pass filter used to block RFI at the input to receivers
 - As a low-pass filter used between a transmitter and a transmission line
 - For smoothing power supply output
 - As an audio filter in a receiver
37. Which of the following oscillator circuits are commonly used in VFOs?
- Pierce and Zener
 - Colpitts and Hartley
 - Armstrong and deForest
 - Negative feedback and balanced feedback
38. What is the approximate ratio of PEP-to-average power in a typical single-sideband phone signal?
- 2.5 to 1
 - 25 to 1
 - 1 to 1
 - 100 to 1
39. What is the deviation ratio of an FM-phone signal having a maximum frequency swing of plus or minus 7.5 kHz when the maximum modulation frequency is 3.5 kHz?
- 2.14
 - 0.214
 - 0.47
 - 47

40. What is the necessary bandwidth of a 170-hertz shift, 300-baud ASCII transmission?
- 0.1 Hz
 - 0.3 kHz
 - 0.5 kHz
 - 1.0 kHz
41. Which of the following indicates likely overmodulation of an AFSK signal such as PSK or MFSK?
- High reflected power
 - Strong ALC action
 - Harmonics on higher bands
 - Rapid signal fading
42. How does the beamwidth of an antenna vary as the gain is increased?
- It increases geometrically
 - It increases arithmetically
 - It is essentially unaffected
 - It decreases

Question 43 pertains to the following graphic:

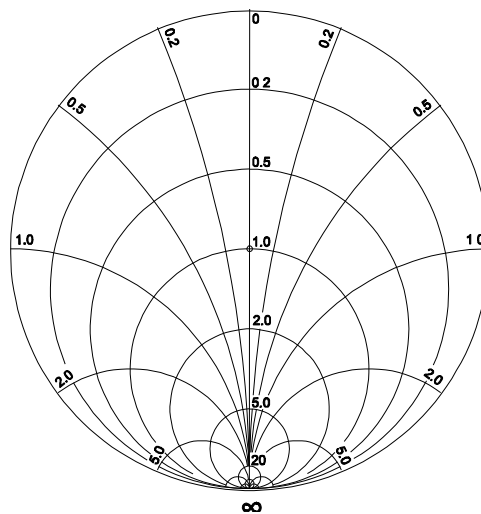


43. What is the elevation angle of peak response in the antenna radiation pattern shown in Figure E9-2?
- 45 degrees
 - 75 degrees
 - 7.5 degrees
 - 25 degrees
44. What is the effect of a terminating resistor on a rhombic antenna?
- It reflects the standing waves on the antenna elements back to the transmitter
 - It changes the radiation pattern from bidirectional to unidirectional
 - It changes the radiation pattern from horizontal to vertical polarization
 - It decreases the ground loss

45. What happens to the bandwidth of an antenna as it is shortened through the use of loading coils?
- It is increased
 - It is decreased
 - No change occurs
 - It becomes flat
46. What is the equivalent lumped-constant network for a hairpin matching system of a 3-element Yagi?
- Pi-network
 - Pi-L-network
 - A shunt inductor
 - A series capacitor
47. What is the approximate physical length of an air-insulated, parallel conductor transmission line that is electrically one-half wavelength long at 14.10 MHz?
- 15 meters
 - 20 meters
 - 10 meters
 - 71 meters

Question 48 pertains to the following graphic:

Figure E9-3



48. On the Smith chart shown in Figure E9-3, what is the name for the large outer circle on which the reactance arcs terminate?
- Prime axis
 - Reactance axis
 - Impedance axis
 - Polar axis

49. Why is it advisable to use an RF attenuator on a receiver being used for direction finding?
- a. It narrows the bandwidth of the received signal to improve signal to noise ratio
 - b. It compensates for the effects of an isotropic antenna, thereby improving directivity
 - c. It reduces loss of received signals caused by antenna pattern nulls, thereby increasing sensitivity
 - d. It prevents receiver overload which could make it difficult to determine peaks or nulls
50. Why are there separate electric (E) and magnetic (H) field MPE limits?
- a. The body reacts to electromagnetic radiation from both the E and H fields
 - b. Ground reflections and scattering make the field impedance vary with location
 - c. E field and H field radiation intensity peaks can occur at different locations
 - d. All of these choices are correct

Test #6 Answer Key and Explanations

1. B: The carrier frequency of a CW signal must be set at the center frequency of the channel to comply with FCC rules.
2. A: If installing an amateur station antenna at a site at or near a public use airport, you may have to notify the Federal Aviation Administration and register it with the FCC as required by Part 17 of FCC rules.
3. C: A control operator must be present at the control point of a remotely controlled amateur station.
4. A: A space station must be capable of terminating transmissions by telecommand when directed by the FCC.
5. C: Each administering VE is responsible for the proper conduct and necessary supervision during an amateur operator license examination session.
6. A: The FCC might issue a Special Temporary Authority (STA) to an amateur station to provide for experimental amateur communications.
7. A: A satellite would receive signals between 435 MHz and 438 MHz if it were operating in mode U/V.
8. A: Vestigial sideband modulation is amplitude modulation in which one complete sideband and a portion of the other are transmitted.
9. C: During a VHF/UHF contest, you would expect to find the highest activity in the weak signal segment of the band, with most of the activity near the calling frequency.
10. A: Establishing EME contacts can be done by timing synchronous transmissions alternately from each station.
11. C: The most common data rate used for HF packets is 300 baud.
12. C: For microwave propagation via rain scatter, the rain must be within radio range of both stations.
13. B: The amateur 20 meter band supports long-path propagation more frequently than the 6, 10, or 80 meter bands.
14. A: The VHF/UHF radio horizon distance exceeds the geometric horizon by approximately 15 percent of the distance.
15. A: Aliasing in a digital or computer-based oscilloscope means that false signals are being displayed.
16. D: 75 watts of power are being absorbed by the load when a directional power meter connected between a transmitter and a terminating load reads 100 watts forward power and 25 watts reflected power.
17. D: -148 dBm is the level of an unmodulated carrier input to this receiver that would yield an audio output SNR of 0 dB in a 400 Hz noise bandwidth.

18. D: Intermodulation interference is an unwanted signal generated by the mixing of two or more signals.
19. B: Thunderstorms are a major cause of atmospheric static.
20. B: The magnitude of the circulating current within the components of a parallel LC circuit at resonance is at a maximum.
21. C: Susceptance is the inverse of reactance.
22. B: The impedance $50-j25$ represents 50 ohms resistance in series with 25 ohms capacitive reactance.
23. D: the magnetic field is oriented in a direction determined by the left-hand rule about a conductor in relation to the direction of electron flow.
24. B: The beta of a bipolar junction transistor is the change in collector current with respect to the base current.
25. D: Hot-carrier diodes are often used as VHF/UHF mixers or detectors.
26. C: CMOS digital integrated circuits have high immunity to noise on the input signal because the input switching threshold is about one-half the power supply voltage.
27. D: Permeability of the core material determines the inductance of a toroidal inductor.
28. D: MMICs have controlled gain, low noise figures, and constant input and output impedances over the specified frequency range, making them popular for VHF through microwave circuits.
29. A: Crystalline semiconductors are most affected by photoconductivity.
30. A: monostable multivibrators switch momentarily to the opposite binary state and then return to their original state after a set time.
31. B: Push-pull amplifiers reduce or eliminate even order harmonics.
32. C: An elliptical filter has an extremely sharp cutoff with one or more notches in the stop band.
33. C: The purpose of Q1 in the circuit shown in Figure E7-3 is increasing the current-handling capability of the regulator.
21. C: Susceptance is the inverse of reactance.
22. B: The impedance $50-j25$ represents 50 ohms resistance in series with 25 ohms capacitive reactance.
23. D: the magnetic field is oriented in a direction determined by the left-hand rule about a conductor in relation to the direction of electron flow.
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30. A: Monostable multivibrators switch momentarily to the opposite binary state and then return to their original state after a set time.
31. B: Push-pull amplifiers reduce or eliminate even order harmonics.
32. C: An elliptical filter has an extremely sharp cutoff with one or more notches in the stop band.
33. C: The purpose of Q1 in the circuit shown in Figure E7-3 is increasing the current-handling capability of the regulator.
34. A: De-emphasis is commonly used in FM communications receivers for compatibility with transmitters using phase modulation.
35. D: The minimum number of bits required for an analog-to-digital converter to sample a signal with a range of 1 volt at a resolution of 1 millivolt is 10.
36. D: The most appropriate use of an op-amp active filter is as an audio filter in a receiver.
37. B: Colpitts and Hartley oscillator circuits are commonly used in VFOs.
38. A: The approximate ratio of PEP-to-average power in a typical single-sideband phone signal is 2.5 to 1.
39. A: The deviation ratio of an FM-phone signal having a maximum frequency swing of plus or minus 7.5 kHz when the maximum modulation frequency is 3.5 kHz is 2.14.
40. C: A 170-hertz shift, 300-baud ASCII transmission requires a bandwidth of 0.5 kHz.
41. B: Strong ALC action indicates likely overmodulation of an AFSK signal such as PSK or MFSK.
42. D: The beamwidth of an antenna decreases as the gain is increased.
43. C: The elevation angle of peak response in the antenna radiation pattern shown in Figure E9-2 is 7.5 degrees.
44. B: A terminating resistor on a rhombic antenna changes the radiation pattern from bidirectional to unidirectional.
45. B: As an antenna is shortened through the use of loading coils, the bandwidth decreases.
46. C: A shunt inductor is the equivalent lumped-constant network for a hairpin matching system of a 3-element Yagi.

47. C: An air-insulated, parallel conductor transmission line that is electrically one-half wavelength long at 14.10 MHz has an approximate physical length of 10 meters.

48. B: The large outer circle on which the reactance arcs terminate is the reactance axis in Figure E9-3.

49. D: An RF attenuator on a receiver being used for direction finding prevents receiver overload.

50. D: There are multiple reasons why there are separate electric (E) and magnetic (H) field MPE limits, including different body reactions, varying field impedance due to ground reflections and scattering, and different radiation intensity peaks.

Test #7 Practice Questions

1. Which amateur band requires transmission on specific channels rather than on a range of frequencies?
 - a. 12 meter band
 - b. 17 meter band
 - c. 30 meter band
 - d. 60 meter band
2. What is the highest modulation index permitted at the highest modulation frequency for angle modulation below 29.0 MHz?
 - a. 0.5
 - b. 1.0
 - c. 2.0
 - d. 3.0
3. What is meant by local control?
 - a. Controlling a station through a local auxiliary link
 - b. Automatically manipulating local station controls
 - c. Direct manipulation of the transmitter by a control operator
 - d. Controlling a repeater using a portable handheld transceiver
4. Which amateur service HF bands have frequencies authorized for space stations?
 - a. Only the 40 m, 20 m, 17 m, 15 m, 12 m and 10 m bands
 - b. Only the 40 m, 20 m, 17 m, 15 m and 10 m bands
 - c. Only the 40 m, 30 m, 20 m, 15 m, 12 m and 10 m bands
 - d. All HF bands
5. What should a VE do if a candidate fails to comply with the examiner's instructions during an amateur operator license examination?
 - a. Warn the candidate that continued failure to comply will result in termination of the examination
 - b. Immediately terminate the candidate's examination
 - c. Allow the candidate to complete the examination, but invalidate the results
 - d. Immediately terminate everyone's examination and close the session
6. When may an amateur station send a message to a business?
 - a. When the total money involved does not exceed \$25
 - b. When the control operator is employed by the FCC or another government agency
 - c. When transmitting international third-party communications
 - d. When neither the amateur nor his or her employer has a pecuniary interest in the communications
7. Which of the following types of signals can be relayed through a linear transponder?
 - a. FM and CW
 - b. SSB and SSTV
 - c. PSK and Packet
 - d. All of these choices are correct

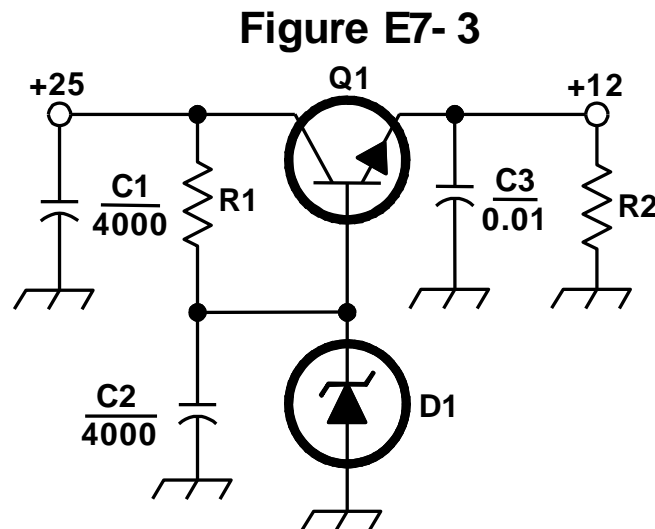
8. What is the name of the signal component that carries color information in NTSC video?
- Luminance
 - Chroma
 - Hue
 - Spectral Intensity
9. What is the Cabrillo format?
- A standard for submission of electronic contest logs
 - A method of exchanging information during a contest QSO
 - The most common set of contest rules
 - The rules of order for meetings between contest sponsors
10. What digital protocol is used by APRS?
- PACTOR
 - 802.11
 - AX.25
 - AMTOR
11. What is the typical bandwidth of a properly modulated MFSK16 signal?
- 31 Hz
 - 316 Hz
 - 550 Hz
 - 2.16 kHz
12. Atmospheric ducts capable of propagating microwave signals often form over what geographic feature?
- Mountain ranges
 - Forests
 - Bodies of water
 - Urban areas
13. Which of the following could account for hearing an echo on the received signal of a distant station?
- High D layer absorption
 - Meteor scatter
 - Transmit frequency is higher than the MUF
 - Receipt of a signal by more than one path
14. Which of the following descriptors indicates the greatest solar flare intensity?
- Class A
 - Class B
 - Class M
 - Class X

15. Which of the following is an advantage of using an antenna analyzer compared to an SWR bridge to measure antenna SWR?
- Antenna analyzers automatically tune your antenna for resonance
 - Antenna analyzers do not need an external RF source
 - Antenna analyzers display a time-varying representation of the modulation envelope
 - All of these choices are correct
16. What do the subscripts of S parameters represent?
- The port or ports at which measurements are made
 - The relative time between measurements
 - Relative quality of the data
 - Frequency order of the measurements
17. What does the MDS of a receiver represent?
- The meter display sensitivity
 - The minimum discernible signal
 - The multiplex distortion stability
 - The maximum detectable spectrum
18. Which describes the most significant effect of an off-frequency signal when it is causing cross-modulation interference to a desired signal?
- A large increase in background noise
 - A reduction in apparent signal strength
 - The desired signal can no longer be heard
 - The off-frequency unwanted signal is heard in addition to the desired signal
19. How can you determine if line noise interference is being generated within your home?
- By checking the power line voltage with a time domain reflectometer
 - By observing the AC power line waveform with an oscilloscope
 - By turning off the AC power line main circuit breaker and listening on a battery operated radio
 - By observing the AC power line voltage with a spectrum analyzer
20. What is the magnitude of the current at the input of a parallel RLC circuit at resonance?
- Minimum
 - Maximum
 - R/L
 - L/R
21. What is the phase angle between the voltage across and the current through a series RLC circuit if X_C is 500 ohms, R is 1 kilohm, and X_L is 250 ohms?
- 68.2 degrees with the voltage leading the current
 - 14.0 degrees with the voltage leading the current
 - 14.0 degrees with the voltage lagging the current
 - 68.2 degrees with the voltage lagging the current

22. What is a vector?
- The value of a quantity that changes over time
 - A quantity with both magnitude and an angular component
 - The inverse of the tangent function
 - The inverse of the sine function
23. What determines the strength of the magnetic field around a conductor?
- The resistance divided by the current
 - The ratio of the current to the resistance
 - The diameter of the conductor
 - The amount of current flowing through the conductor
24. Which of the following indicates that a silicon NPN junction transistor is biased on?
- Base-to-emitter resistance of approximately 6 to 7 ohms
 - Base-to-emitter resistance of approximately 0.6 to 0.7 ohms
 - Base-to-emitter voltage of approximately 6 to 7 volts
 - Base-to-emitter voltage of approximately 0.6 to 0.7 volts
25. What is the failure mechanism when a junction diode fails due to excessive current?
- Excessive inverse voltage
 - Excessive junction temperature
 - Insufficient forward voltage
 - Charge carrier depletion
26. What best describes a pull-up or pull-down resistor?
- A resistor in a keying circuit used to reduce key clicks
 - A resistor connected to the positive or negative supply line used to establish a voltage when an input or output is an open circuit
 - A resistor that insures that an oscillator frequency does not drive lower over time
 - A resistor connected to an op-amp output that only functions when the logic output is false
27. What is the usable frequency range of inductors that use toroidal cores, assuming a correct selection of core material for the frequency being used?
- From a few kHz to no more than 30 MHz
 - From less than 20 Hz to approximately 300 MHz
 - From approximately 10 Hz to no more than 3000 kHz
 - From about 100 kHz to at least 1000 GHz
28. Which of the following is typically used to construct a MMIC-based microwave amplifier?
- Ground-plane construction
 - Microstrip construction
 - Point-to-point construction
 - Wave-soldering construction
29. What is a solid state relay?
- A relay using transistors to drive the relay coil
 - A device that uses semiconductors to implement the functions of an electromechanical relay
 - A mechanical relay that latches in the on or off state each time it is pulsed
 - A passive delay line

30. What logical operation does a NAND gate perform?
- It produces logic "0" at its output only when all inputs are logic "0"
 - It produces logic "1" at its output only when all inputs are logic "1"
 - It produces logic "0" at its output if some but not all inputs are logic "1"
 - It produces logic "0" at its output only when all inputs are logic "1"
31. Which of the following is a likely result when a Class C amplifier is used to amplify a single-sideband phone signal?
- Reduced intermodulation products
 - Increased overall intelligibility
 - Signal inversion
 - Signal distortion and excessive bandwidth
32. What kind of filter would you use to attenuate an interfering carrier signal while receiving an SSB transmission?
- A band-pass filter
 - A notch filter
 - A Pi-network filter
 - An all-pass filter

Question 33 pertains to the following graphic:

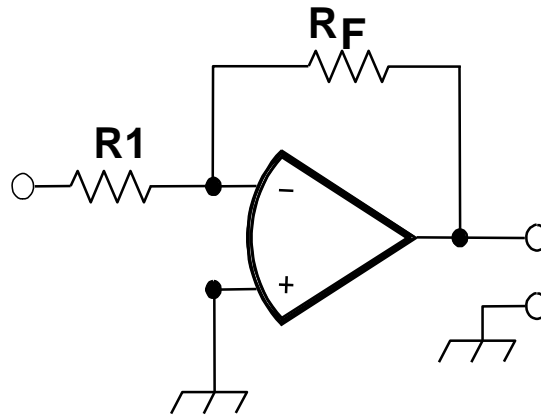


33. What is the purpose of C2 in the circuit shown in Figure E7-3?
- It bypasses hum around D1
 - It is a brute force filter for the output
 - To self-resonate at the hum frequency
 - To provide fixed DC bias for Q1
34. What is meant by the term baseband in radio communications?
- The lowest frequency band that the transmitter or receiver covers
 - The frequency components present in the modulating signal
 - The unmodulated bandwidth of the transmitted signal
 - The basic oscillator frequency in an FM transmitter that is multiplied to increase the deviation and carrier frequency

35. What function can a Fast Fourier Transform perform?
- a. Converting analog signals to digital form
 - b. Converting digital signals to analog form
 - c. Converting digital signals from the time domain to the frequency domain
 - d. Converting 8-bit data to 16 bit data

Question 36 pertains to the following graphic:

Figure E7-4



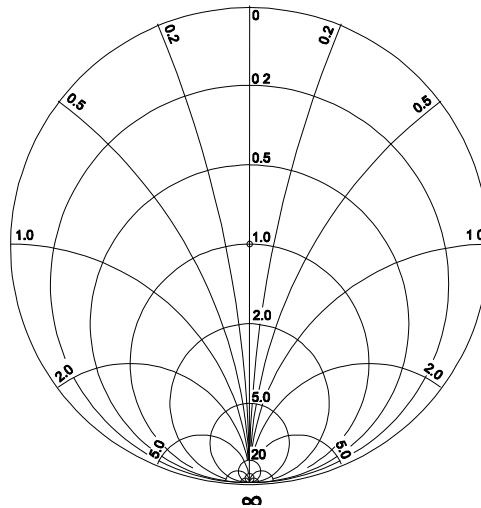
36. What magnitude of voltage gain can be expected from the circuit in Figure E7-4 when R1 is 10 ohms and RF is 470 ohms?
- a. 0.21
 - b. 94
 - c. 47
 - d. 24
37. How can an oscillator's microphonic responses be reduced?
- a. Use of NP0 capacitors
 - b. Eliminating noise on the oscillator's power supply
 - c. Using the oscillator only for CW and digital signals
 - d. Mechanically isolating the oscillator circuitry from its enclosure
38. What determines the PEP-to-average power ratio of a single-sideband phone signal?
- a. The frequency of the modulating signal
 - b. The characteristics of the modulating signal
 - c. The degree of carrier suppression
 - d. The amplifier gain
39. Orthogonal Frequency Division Multiplexing is a technique used for which type of amateur communication?
- a. High speed digital modes
 - b. Extremely low-power contacts
 - c. EME
 - d. OFDM signals are not allowed on amateur bands

40. What is the necessary bandwidth of a 4800-Hz frequency shift, 9600-baud ASCII FM transmission?
- 15.36 kHz
 - 9.6 kHz
 - 4.8 kHz
 - 5.76 kHz
41. What is a common cause of overmodulation of AFSK signals?
- Excessive numbers of retries
 - Ground loops
 - Bit errors in the modem
 - Excessive transmit audio levels
42. How does the beamwidth of an antenna vary as the gain is increased?
- It increases geometrically
 - It increases arithmetically
 - It is essentially unaffected
 - It decreases
43. How does the total amount of radiation emitted by a directional gain antenna compare with the total amount of radiation emitted from an isotropic antenna, assuming each is driven by the same amount of power?
- The total amount of radiation from the directional antenna is increased by the gain of the antenna
 - The total amount of radiation from the directional antenna is stronger by its front-to-back ratio
 - They are the same
 - The radiation from the isotropic antenna is 2.15 dB stronger than that from the directional antenna
44. What is the approximate feed point impedance at the center of a two-wire folded dipole antenna?
- 300 ohms
 - 72 ohms
 - 50 ohms
 - 450 ohms
45. What is an advantage of using top loading in a shortened HF vertical antenna?
- Lower Q
 - Greater structural strength
 - Higher losses
 - Improved radiation efficiency
46. What term best describes the interactions at the load end of a mismatched transmission line?
- Characteristic impedance
 - Reflection coefficient
 - Velocity factor
 - Dielectric constant

47. How does ladder line compare to small-diameter coaxial cable such as RG-58 at 50 MHz?
- a. Lower loss
 - b. Higher SWR
 - c. Smaller reflection coefficient
 - d. Lower velocity factor

Question 48 pertains to the following graphic:

Figure E9-3



48. On the Smith chart shown in Figure E9-3, what is the only straight line shown?
- a. The reactance axis
 - b. The current axis
 - c. The voltage axis
 - d. The resistance axis
49. What is the function of a sense antenna?
- a. It modifies the pattern of a DF antenna array to provide a null in one direction
 - b. It increases the sensitivity of a DF antenna array
 - c. It allows DF antennas to receive signals at different vertical angles
 - d. It provides diversity reception that cancels multipath signals
50. How may dangerous levels of carbon monoxide from an emergency generator be detected?
- a. By the odor
 - b. Only with a carbon monoxide detector
 - c. Any ordinary smoke detector can be used
 - d. By the yellowish appearance of the gas

Test #7 Answer Key and Explanations

1. D: The 60-meter band requires transmission on specific channels rather than on a range of frequencies.
2. B: The highest modulation index permitted at the highest modulation frequency for angle modulation below 29.0 MHz is 1.0.
3. C: Local control is direct manipulation of the transmitter by a control operator.
4. A: Only the 40 m, 20 m, 17 m, 15 m, 12 m and 10 m bands have frequencies authorized for space stations.
5. B: If a candidate fails to comply with the examiner's instructions during an amateur operator license examination, the VE should immediately terminate the candidate's examination.
6. D: An amateur station may send a message to a business when neither the amateur nor his or her employer has a pecuniary interest in the communications.
7. D: FM, CW, SSB, SSTV, PSK, and Packet signals can all be relayed through a linear transponder.
8. B: The signal component that carries color information in NTSC video is chroma.
9. A: The Cabrillo format is a standard for submission of electronic contest logs.
10. C: The AX.25 digital protocol is used by APRS.
11. B: The typical bandwidth of a properly modulated MFSK16 signal is 316 Hz.
12. C: Atmospheric ducts capable of propagating microwave signals often form over bodies of water.
13. D: Receipt of a signal by more than one path could account for hearing an echo on the received signal of a distant station.
14. D: A class X descriptor indicates the greatest solar flare intensity.
15. B: An advantage of using an antenna analyzer compared to an SWR bridge to measure antenna SWR is that antenna analyzers do not need an external RF source.
16. A: The subscripts of S parameters represent the port or ports at which measurements are made.
17. B: The MDS of a receiver represents the minimum discernible signal.
18. D: When an off-frequency signal is causing cross-modulation interference to a desired signal, the off-frequency signal is heard in addition to the desired signal.
19. C: You can determine if line noise interference is being generated within your home by turning off the AC power line main circuit breaker and listening on a battery operated radio.
20. A: The magnitude of the current at the input of a parallel RLC circuit at resonance is at a minimum.

21. C: The phase angle of a series RLC circuit with $X_C = 500$ ohms, $R = 1$ kilohm, and $X_L = 250$ ohms is 14.0 degrees with the voltage lagging the current.
22. B: A vector is a quantity with both magnitude and an angular component.
23. D: The amount of current flowing through a conductor determines the strength of the magnetic field around it.
24. D: A base-to-emitter voltage of approximately 0.6 to 0.7 volts would indicate that a silicon NPN junction transistor is biased on.
25. B: When a junction diode fails due to excessive current, it is called an excessive junction temperature failure.
26. B: Pull-up or pull-down resistors are connected to the positive or negative supply line and used to establish a voltage when an input or output is an open circuit.
27. B: Inductors that use toroidal cores range from less than 20 Hz to approximately 300 MHz.
28. B: Microstrip construction is typically used to construct a MMIC-based microwave amplifier.
29. B: A solid state relay is a device that uses semiconductors to implement the functions of an electromechanical relay.
30. D: NAND gates produce a logic "0" at their output only when all inputs are logic "1".
31. D: Signal distortion and excessive bandwidth can result from a class C amplifier being used to amplify a single-sideband phone signal.
32. B: A notch filter could be used to attenuate an interfering carrier signal while receiving an SSB transmission.
33. A: The purpose of C2 in the circuit shown in Figure E7-3 is bypassing hum around D1.
34. B: Baseband is the frequency components present in the modulating signal.
35. C: A Fast Fourier Transform can convert digital signals from the time domain to the frequency domain.
36. C: The voltage gain from the circuit in Figure E7-4 when R1 is 10 ohms and RF is 470 ohms should be 47.
37. D: An oscillator's microphonic responses can be reduced by mechanically isolating the oscillator circuitry from its enclosure.
38. B: The characteristics of the modulating signal determine the PEP-to-average power ratio of a single-sideband phone signal.
39. A: Orthogonal Frequency Division Multiplexing is a technique used for high speed digital modes of amateur communication.
40. A: A 4800-Hz frequency shift, 9600-baud ASCII FM transmission requires a bandwidth of 15.36 kHz.

41. D: A common cause of overmodulation of AFSK signals is excessive transmit audio levels.
42. D: The beamwidth of an antenna decreases as the gain is increased.
43. C: The total amount of radiation emitted by a directional gain antenna is equal to the total amount of radiation emitted from an isotropic antenna, assuming each is driven by the same amount of power.
44. A: The approximate feed point impedance at the center of a two-wire folded dipole antenna is 300 ohms.
45. D: Using top loading in a shortened HF vertical antenna results in improved radiation efficiency.
46. B: Reflection coefficient is the term most applicable to the interactions at the load end of a mismatched transmission line.
47. A: Ladder line has lower loss than small-diameter coaxial cable such as RG-58 at 50 MHz.
48. D: On the Smith chart shown in Figure E9-3, the only straight line shown is the resistance axis.
49. A: A sense antenna modifies the pattern of a DF antenna array to provide a null in one direction.
50. B: Dangerous levels of carbon monoxide from an emergency generator can be detected only with a carbon monoxide detector.

Test #8 Practice Questions

1. If a station in a message forwarding system inadvertently forwards a message that is in violation of FCC rules, who is primarily accountable for the rules violation?
 - a. The control operator of the packet bulletin board station
 - b. The control operator of the originating station
 - c. The control operators of all the stations in the system
 - d. The control operators of all the stations in the system not authenticating the source from which they accept communications

2. What limitations may the FCC place on an amateur station if its signal causes interference to domestic broadcast reception, assuming that the receivers involved are of good engineering design?
 - a. The amateur station must cease operation
 - b. The amateur station must cease operation on all frequencies below 30 MHz
 - c. The amateur station must cease operation on all frequencies above 30 MHz
 - d. The amateur station must avoid transmitting during certain hours on frequencies that cause the interference

3. What is the maximum permissible duration of a remotely controlled station's transmissions if its control link malfunctions?
 - a. 30 seconds
 - b. 3 minutes
 - c. 5 minutes
 - d. 10 minutes

4. Which VHF amateur service bands have frequencies available for space stations?
 - a. 6 meters and 2 meters
 - b. 6 meters, 2 meters, and 1.25 meters
 - c. 2 meters and 1.25 meters
 - d. 2 meters

5. To which of the following examinees may a VE not administer an examination?
 - a. Employees of the VE
 - b. Friends of the VE
 - c. Relatives of the VE as listed in the FCC rules
 - d. All of these choices are correct

6. Which of the following types of amateur station communications are prohibited?
 - a. Communications transmitted for hire or material compensation, except as otherwise provided in the rules
 - b. Communications that have a political content, except as allowed by the Fairness Doctrine
 - c. Communications that have a religious content
 - d. Communications in a language other than English

7. Why should effective radiated power to a satellite which uses a linear transponder be limited?
 - a. To prevent creating errors in the satellite telemetry
 - b. To avoid reducing the downlink power to all other users
 - c. To prevent the satellite from emitting out-of-band signals
 - d. To avoid interfering with terrestrial QSOs

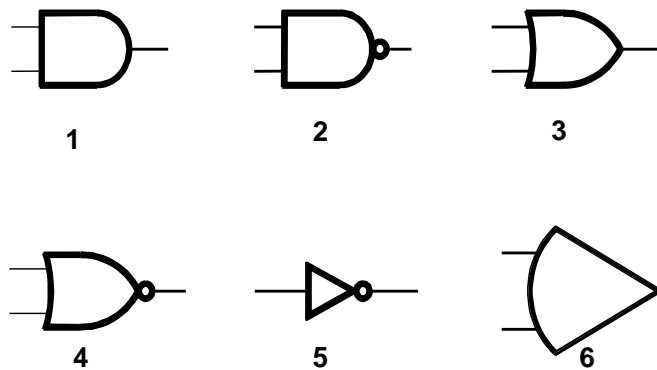
8. Which of the following is a common method of transmitting accompanying audio with amateur fast-scan television?
- Frequency-modulated sub-carrier
 - A separate VHF or UHF audio link
 - Frequency modulation of the video carrier
 - All of these choices are correct
9. Which of the following contacts may be confirmed through the U.S. QSL bureau system?
- Special event contacts between stations in the U.S.
 - Contacts between a U.S. station and a non-U.S. station
 - Repeater contacts between U.S. club members
 - Contacts using tactical call signs
10. What type of packet frame is used to transmit APRS beacon data?
- Unnumbered Information
 - Disconnect
 - Acknowledgement
 - Connect
11. Which of the following HF digital modes can be used to transfer binary files?
- Hellschreiber
 - PACTOR
 - RTTY
 - AMTOR
12. When a meteor strikes the Earth's atmosphere, a cylindrical region of free electrons is formed at what layer of the ionosphere?
- The E layer
 - The F1 layer
 - The F2 layer
 - The D layer
13. What type of HF propagation is probably occurring if radio signals travel along the terminator between daylight and darkness?
- Transequatorial
 - Sporadic-E
 - Long-path
 - Gray-line
14. What does the space weather term G5 mean?
- An extreme geomagnetic storm
 - Very low solar activity
 - Moderate solar wind
 - Waning sunspot numbers

15. Which of the following instruments would be best for measuring the SWR of a beam antenna?
- A spectrum analyzer
 - A Q meter
 - An ohmmeter
 - An antenna analyzer
16. Which of the following is a characteristic of a good DC voltmeter?
- High reluctance input
 - Low reluctance input
 - High impedance input
 - Low impedance input
17. An SDR receiver is overloaded when input signals exceed what level?
- One-half the maximum sample rate
 - One-half the maximum sampling buffer size
 - The maximum count value of the analog-to-digital converter
 - The reference voltage of the analog-to-digital converter
18. What causes intermodulation in an electronic circuit?
- Too little gain
 - Lack of neutralization
 - Nonlinear circuits or devices
 - Positive feedback
19. What type of signal is picked up by electrical wiring near a radio antenna?
- A common-mode signal at the frequency of the radio transmitter
 - An electrical-sparking signal
 - A differential-mode signal at the AC power line frequency
 - Harmonics of the AC power line frequency
20. What is the phase relationship between the current through and the voltage across a series resonant circuit at resonance?
- The voltage leads the current by 90 degrees
 - The current leads the voltage by 90 degrees
 - The voltage and current are in phase
 - The voltage and current are 180 degrees out of phase
21. What is the phase angle between the voltage across and the current through a series RLC circuit if X_C is 100 ohms, R is 100 ohms, and X_L is 75 ohms?
- 14 degrees with the voltage lagging the current
 - 14 degrees with the voltage leading the current
 - 76 degrees with the voltage leading the current
 - 76 degrees with the voltage lagging the current

22. What coordinate system is often used to display the phase angle of a circuit containing resistance, inductive and/or capacitive reactance?
- Maidenhead grid
 - Faraday grid
 - Elliptical coordinates
 - Polar coordinates
23. What type of energy is stored in an electromagnetic or electrostatic field?
- Electromechanical energy
 - Potential energy
 - Thermodynamic energy
 - Kinetic energy
24. What term indicates the frequency at which the grounded-base current gain of a transistor has decreased to 0.7 of the gain obtainable at 1 kHz?
- Corner frequency
 - Alpha rejection frequency
 - Beta cutoff frequency
 - Alpha cutoff frequency
25. Which of the following describes a type of semiconductor diode?
- Metal-semiconductor junction
 - Electrolytic rectifier
 - CMOS-field effect
 - Thermionic emission diode

Question 26 pertains to the following graphic:

Figure E6-5

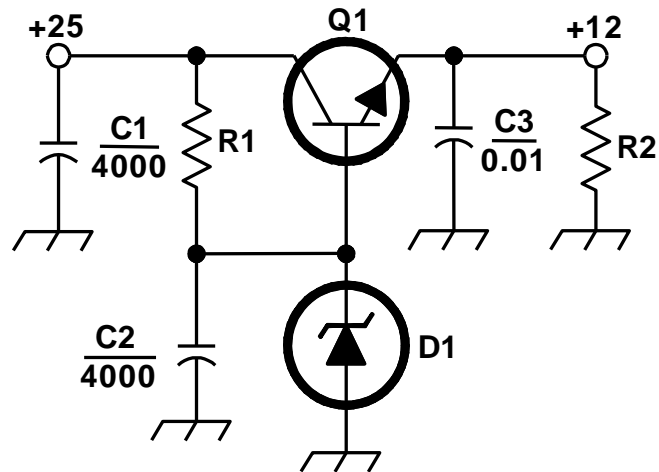


26. In Figure E6-5, what is the schematic symbol for a NAND gate?
- 1
 - 2
 - 3
 - 4

27. What is one reason for using powdered-iron cores rather than ferrite cores in an inductor?
- Powdered-iron cores generally have greater initial permeability
 - Powdered-iron cores generally maintain their characteristics at higher currents
 - Powdered-iron cores generally require fewer turns to produce a given inductance
 - Powdered-iron cores use smaller diameter wire for the same inductance
28. How is voltage from a power supply normally furnished to the most common type of monolithic microwave integrated circuit (MMIC)?
- Through a resistor and/or RF choke connected to the amplifier output lead
 - MMICs require no operating bias
 - Through a capacitor and RF choke connected to the amplifier input lead
 - Directly to the bias voltage (VCC IN) lead
29. Why are optoisolators often used in conjunction with solid state circuits when switching 120VAC?
- Optoisolators provide a low impedance link between a control circuit and a power circuit
 - Optoisolators provide impedance matching between the control circuit and power circuit
 - Optoisolators provide a very high degree of electrical isolation between a control circuit and the circuit being switched
 - Optoisolators eliminate the effects of reflected light in the control circuit
30. What logical operation does an OR gate perform?
- It produces logic "1" at its output if any or all inputs are logic "1"
 - It produces logic "0" at its output if all inputs are logic "1"
 - It only produces logic "0" at its output when all inputs are logic "1"
 - It produces logic "1" at its output if all inputs are logic "0"
31. How can an RF power amplifier be neutralized?
- By increasing the driving power
 - By reducing the driving power
 - By feeding a 180-degree out-of-phase portion of the output back to the input
 - By feeding an in-phase component of the output back to the input
32. Which of the following factors has the greatest effect in helping determine the bandwidth and response shape of a crystal ladder filter?
- The relative frequencies of the individual crystals
 - The DC voltage applied to the quartz crystal
 - The gain of the RF stage preceding the filter
 - The amplitude of the signals passing through the filter

Question 33 pertains to the following graphic:

Figure E7- 3



33. What type of circuit is shown in Figure E7-3?
- Switching voltage regulator
 - Grounded emitter amplifier
 - Linear voltage regulator
 - Emitter follower
34. What are the principal frequencies that appear at the output of a mixer circuit?
- Two and four times the original frequency
 - The sum, difference and square root of the input frequencies
 - The two input frequencies along with their sum and difference frequencies
 - 1.414 and 0.707 times the input frequency
35. What is the function of decimation with regard to digital filters?
- Converting data to binary code decimal form
 - Reducing the effective sample rate by removing samples
 - Attenuating the signal
 - Removing unnecessary significant digits
36. How does the gain of an ideal operational amplifier vary with frequency?
- It increases linearly with increasing frequency
 - It decreases linearly with increasing frequency
 - It decreases logarithmically with increasing frequency
 - It does not vary with frequency
37. Which of the following components can be used to reduce thermal drift in crystal oscillators?
- NPO capacitors
 - Toroidal inductors
 - Wirewound resistors
 - Non-inductive resistors

38. Why would a direct or flash conversion analog-to-digital converter be useful for a software-defined radio?
- Very low power consumption decreases frequency drift
 - Immunity to out of sequence coding reduces spurious responses
 - Very high speed allows digitizing high frequencies
 - All of these choices are correct
39. What describes Orthogonal Frequency Division Multiplexing?
- A frequency modulation technique which uses non-harmonically related frequencies
 - A bandwidth compression technique using Fourier transforms
 - A digital mode for narrow band, slow speed transmissions
 - A digital modulation technique using subcarriers at frequencies chosen to avoid intersymbol interference
40. How does ARQ accomplish error correction?
- Special binary codes provide automatic correction
 - Special polynomial codes provide automatic correction
 - If errors are detected, redundant data is substituted
 - If errors are detected, a retransmission is requested
41. What parameter might indicate that excessively high input levels are causing distortion in an AFSK signal?
- Signal to noise ratio
 - Baud rate
 - Repeat Request Rate (RRR)
 - Intermodulation Distortion (IMD)
42. What is meant by antenna gain?
- The ratio of the radiated signal strength of an antenna in the direction of maximum radiation to that of a reference antenna
 - The ratio of the signal in the forward direction to that in the opposite direction
 - The ratio of the amount of power radiated by an antenna compared to the transmitter output power
 - The final amplifier gain minus the transmission line losses
43. How can the approximate beam-width in a given plane of a directional antenna be determined?
- Note the two points where the signal strength of the antenna is 3 dB less than maximum and compute the angular difference
 - Measure the ratio of the signal strengths of the radiated power lobes from the front and rear of the antenna
 - Draw two imaginary lines through the ends of the elements and measure the angle between the lines
 - Measure the ratio of the signal strengths of the radiated power lobes from the front and side of the antenna

44. What is a folded dipole antenna?
- A dipole one-quarter wavelength long
 - A type of ground-plane antenna
 - A dipole consisting of one wavelength of wire forming a very thin loop
 - A dipole configured to provide forward gain
45. What happens as the Q of an antenna increases?
- SWR bandwidth increases
 - SWR bandwidth decreases
 - Gain is reduced
 - More common-mode current is present on the feed line
46. Which of the following measurements is characteristic of a mismatched transmission line?
- An SWR less than 1:1
 - A reflection coefficient greater than 1
 - A dielectric constant greater than 1
 - An SWR greater than 1:1
47. What is the term for the ratio of the actual speed at which a signal travels through a transmission line to the speed of light in a vacuum?
- Velocity factor
 - Characteristic impedance
 - Surge impedance
 - Standing wave ratio
48. What is the process of normalization with regard to a Smith chart?
- Reassigning resistance values with regard to the reactance axis
 - Reassigning reactance values with regard to the resistance axis
 - Reassigning impedance values with regard to the prime center
 - Reassigning prime center with regard to the reactance axis
49. Which of the following describes the construction of a receiving loop antenna?
- A large circularly polarized antenna
 - A small coil of wire tightly wound around a toroidal ferrite core
 - One or more turns of wire wound in the shape of a large open coil
 - A vertical antenna coupled to a feed line through an inductive loop of wire
50. What does SAR measure?
- Synthetic Aperture Ratio of the human body
 - Signal Amplification Rating
 - The rate at which RF energy is absorbed by the body
 - The rate of RF energy reflected from stationary terrain

Test #8 Answer Key and Explanations

1. B: The control operator of the originating station is primarily accountable if a forwarded message violates FCC rules.
2. D: If an amateur station causes interference to domestic broadcast reception, the FCC may require that the station avoid transmitting during certain hours on frequencies that cause the interference.
3. B: The maximum permissible duration of a remotely controlled station's transmissions if its control link malfunctions is 3 minutes.
4. D: The 2-meter amateur service bands have frequencies available for space stations.
5. C: A VE may not administer an examination to his or her own relatives, as listed in the FCC rules.
6. A: Amateur station communications transmitted for hire or material compensation are prohibited, except as otherwise provided in the rules.
7. B: Effective radiated power should be limited to a satellite which uses a linear transponder to avoid reducing the downlink power to all other users.
8. D: Frequency-modulated sub-carriers, separate VHF or UHF audio links, and frequency modulation of the video carrier are all common methods of transmitting accompanying audio with amateur fast-scan television.
9. B: Contacts between a U.S. station and a non-U.S. station may be confirmed through the U.S. QSL bureau system.
10. A: Unnumbered Information packet frames are used to transmit APRS beacon data.
11. B: PACTOR can be used to transfer binary files.
12. A: When a meteor strikes the Earth's atmosphere, a cylindrical region of free electrons is formed at the E layer of the ionosphere.
13. D: Gray-line HF propagation is probably occurring if radio signals travel along the terminator between daylight and darkness.
14. A: The space weather term G5 indicates an extreme geomagnetic storm.
15. D: An antenna analyzer would be best for measuring the SWR of a beam antenna.
16. C: High impedance input is a characteristic of a good DC voltmeter.
17. C: An SDR receiver is overloaded when input signals exceed the maximum count value of the analog-to-digital converter.
18. C: Nonlinear circuits or devices cause intermodulation in an electronic circuit.
19. A: A common-mode signal at the frequency of the radio transmitter is picked up by electrical wiring near a radio antenna.
20. C: In a series resonant circuit at resonance, the voltage and current are in phase.

21. A: The phase angle of a series RLC circuit with $X_C = 100$ ohms, $R = 100$ ohms, and $X_L = 75$ ohms is 14 degrees with the voltage lagging the current.
22. D: Polar coordinates are often used to display the phase angle of a circuit containing resistance, inductive and/or capacitive reactance.
23. B: Potential energy is stored in an electromagnetic or electrostatic field.
24. D: Alpha cutoff frequency is the frequency at which the grounded-base current gain of a transistor has decreased to 0.7 of the gain obtainable at 1 kHz.
25. A: Metal-semiconductor junctions are used to make Schottky diodes.
26. B: In Figure E6-5, the schematic symbol for a NAND gate is 2.
27. B: Powdered-iron cores generally maintain their characteristics at higher currents than ferrite cores.
28. A: Power supplies are normally connected to MMICs through a resistor and/or RF choke connected to the amplifier output lead.
29. C: Optoisolators are often used in conjunction with solid state circuits when switching 120VAC because they provide a very high degree of electrical isolation between a control circuit and the circuit being switched.
30. A: OR gates produce logic "1" at their output if any or all inputs are logic "1".
31. C: An RF power amplifier can be neutralized by feeding a 180-degree out-of-phase portion of the output back to the input.
32. A: The relative frequencies of the individual crystals have the greatest effect in helping determine the bandwidth and response shape of a crystal ladder filter.
33. C: A linear voltage regulator is shown in Figure E7-3.
34. C: The principal frequencies that appear at the output of a mixer circuit are the two input frequencies along with their sum and difference frequencies.
35. B: Decimation is reducing the effective sample rate by removing samples.
36. D: The gain of an ideal operational amplifier does not vary with frequency.
37. A: NP0 capacitors can be used to reduce thermal drift in crystal oscillators.
38. C: A direct or flash conversion analog-to-digital converter would be useful for a software-defined radio because the very high speed allows digitizing high frequencies.
39. D: Orthogonal Frequency Division Multiplexing is a digital modulation technique using subcarriers at frequencies chosen to avoid intersymbol interference.
40. D: ARQ accomplishes error correction by requesting a retransmission if errors are detected.
41. D: Intermodulation Distortion (IMD) might indicate that excessively high input levels are causing distortion in an AFSK signal.

42. A: Antenna gain is the ratio of the radiated signal strength of an antenna in the direction of maximum radiation to that of a reference antenna.
43. A: The approximate beam-width in a given plane of a directional antenna be determined by noting the two points where the signal strength of the antenna is 3 dB less than maximum and computing the angular difference.
44. C: A folded dipole antenna is a dipole consisting of one wavelength of wire forming a very thin loop.
45. B: As the Q of an antenna increases, SWR bandwidth decreases.
46. D: A mismatched transmission line would have a SWR greater than 1:1.
47. A: Velocity factor is the term for the ratio of the actual speed at which a signal travels through a transmission line to the speed of light in a vacuum.
48. C: Normalization with regard to a Smith chart is the process of reassigning reactance values with regard to the resistance axis.
49. C: A receiving loop antenna is one or more turns of wire wound in the shape of a large open coil.
50. C: SAR measures the rate at which RF energy is absorbed by the body.

Test #9 Practice Questions

1. What is the first action you should take if your digital message forwarding station inadvertently forwards a communication that violates FCC rules?
 - a. Discontinue forwarding the communication as soon as you become aware of it
 - b. Notify the originating station that the communication does not comply with FCC rules
 - c. Notify the nearest FCC Field Engineer's office
 - d. Discontinue forwarding all messages

2. Which amateur stations may be operated under RACES rules?
 - a. Only those club stations licensed to Amateur Extra class operators
 - b. Any FCC-licensed amateur station except a Technician class
 - c. Any FCC-licensed amateur station certified by the responsible civil defense organization for the area served
 - d. Any FCC-licensed amateur station participating in the Military Auxiliary Radio System (MARS)

3. Which of these ranges of frequencies is available for an automatically controlled repeater operating below 30 MHz?
 - a. 18.110 MHz – 18.168 MHz
 - b. 24.940 MHz – 24.990 MHz
 - c. 10.100 MHz – 10.150 MHz
 - d. 29.500 MHz – 29.700 MHz

4. Which UHF amateur service bands have frequencies available for a space station?
 - a. 70 cm only
 - b. 70 cm and 13 cm
 - c. 70 cm and 33 cm
 - d. 33 cm and 13 cm

5. What may be the penalty for a VE who fraudulently administers or certifies an examination?
 - a. Revocation of the VE's amateur station license grant and the suspension of the VE's amateur operator license grant
 - b. A fine of up to \$1000 per occurrence
 - c. A sentence of up to one year in prison
 - d. All of these choices are correct

6. Which of the following conditions apply when transmitting spread spectrum emission?
 - a. A station transmitting SS emission must not cause harmful interference to other stations employing other authorized emissions
 - b. The transmitting station must be in an area regulated by the FCC or in a country that permits SS emissions
 - c. The transmission must not be used to obscure the meaning of any communication
 - d. All of these choices are correct

7. What do the terms L band and S band specify with regard to satellite communications?
- The 23 centimeter and 13 centimeter bands
 - The 2 meter and 70 centimeter bands
 - FM and Digital Store-and-Forward systems
 - Which sideband to use
8. What hardware, other than a receiver with SSB capability and a suitable computer, is needed to decode SSTV using Digital Radio Mondiale (DRM)?
- A special IF converter
 - A special front end limiter
 - A special notch filter to remove synchronization pulses
 - No other hardware is needed
9. What type of equipment is commonly used to implement a ham radio mesh network?
- A 2 meter VHF transceiver with a 1200 baud modem
 - An optical cable connection between the USB ports of 2 separate computers
 - A standard wireless router running custom software
 - A 440 MHz transceiver with a 9600 baud modem
10. Which of these digital modes has the fastest data throughput under clear communication conditions?
- AMTOR
 - 170 Hz shift, 45 baud RTTY
 - PSK31
 - 300 baud packet
11. Which of the following HF digital modes uses variable-length coding for bandwidth efficiency?
- RTTY
 - PACTOR
 - MT63
 - PSK31
12. Which of the following frequency ranges is most suited for meteor scatter communications?
- 1.8 MHz – 1.9 MHz
 - 10 MHz – 14 MHz
 - 28 MHz – 148 MHz
 - 220 MHz – 450 MHz
13. At what time of year is Sporadic E propagation most likely to occur?
- Around the solstices, especially the summer solstice
 - Around the solstices, especially the winter solstice
 - Around the equinoxes, especially the spring equinox
 - Around the equinoxes, especially the fall equinox
14. How does the intensity of an X3 flare compare to that of an X2 flare?
- 10 percent greater
 - 50 percent greater
 - Twice as great
 - Four times as great

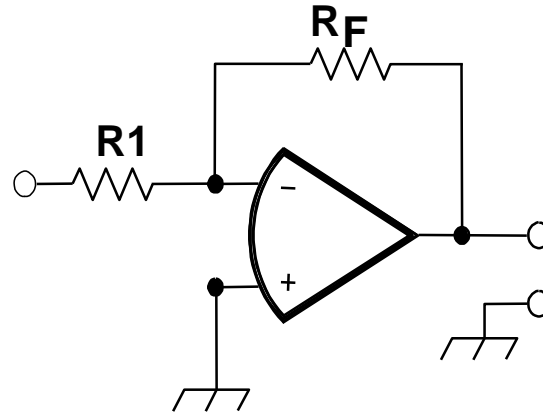
15. When using a computer's soundcard input to digitize signals, what is the highest frequency signal that can be digitized without aliasing?
- The same as the sample rate
 - One-half the sample rate
 - One-tenth the sample rate
 - It depends on how the data is stored internally
16. What is indicated if the current reading on an RF ammeter placed in series with the antenna feed line of a transmitter increases as the transmitter is tuned to resonance?
- There is possibly a short to ground in the feed line
 - The transmitter is not properly neutralized
 - There is an impedance mismatch between the antenna and feed line
 - There is more power going into the antenna
17. Which of the following choices is a good reason for selecting a high frequency for the design of the IF in a conventional HF or VHF communications receiver?
- Fewer components in the receiver
 - Reduced drift
 - Easier for front-end circuitry to eliminate image responses
 - Improved receiver noise figure
18. What is the purpose of the preselector in a communications receiver?
- To store often-used frequencies
 - To provide a range of AGC time constants
 - To increase rejection of unwanted signals
 - To allow selection of the optimum RF amplifier device
19. What undesirable effect can occur when using an IF noise blanker?
- Received audio in the speech range might have an echo effect
 - The audio frequency bandwidth of the received signal might be compressed
 - Nearby signals may appear to be excessively wide even if they meet emission standards
 - FM signals can no longer be demodulated
20. How is the Q of an RLC parallel resonant circuit calculated?
- Reactance of either the inductance or capacitance divided by the resistance
 - Reactance of either the inductance or capacitance multiplied by the resistance
 - Resistance divided by the reactance of either the inductance or capacitance
 - Reactance of the inductance multiplied by the reactance of the capacitance
21. What is the relationship between the current through a capacitor and the voltage across a capacitor?
- Voltage and current are in phase
 - Voltage and current are 180 degrees out of phase
 - Voltage leads current by 90 degrees
 - Current leads voltage by 90 degrees

22. When using rectangular coordinates to graph the impedance of a circuit, what does the horizontal axis represent?
- Resistive component
 - Reactive component
 - The sum of the reactive and resistive components
 - The difference between the resistive and reactive components
23. What happens to reactive power in an AC circuit that has both ideal inductors and ideal capacitors?
- It is dissipated as heat in the circuit
 - It is repeatedly exchanged between the associated magnetic and electric fields, but is not dissipated
 - It is dissipated as kinetic energy in the circuit
 - It is dissipated in the formation of inductive and capacitive fields
24. What is a depletion-mode FET?
- An FET that exhibits a current flow between source and drain when no gate voltage is applied
 - An FET that has no current flow between source and drain when no gate voltage is applied
 - Any FET without a channel
 - Any FET for which holes are the majority carriers
25. What is a common use for point contact diodes?
- As a constant current source
 - As a constant voltage source
 - As an RF detector
 - As a high voltage rectifier
26. What is a Programmable Logic Device (PLD)?
- A device to control industrial equipment
 - A programmable collection of logic gates and circuits in a single integrated circuit
 - Programmable equipment used for testing digital logic integrated circuits
 - An algorithm for simulating logic functions during circuit design
27. What devices are commonly used as VHF and UHF parasitic suppressors at the input and output terminals of a transistor HF amplifier?
- Electrolytic capacitors
 - Butterworth filters
 - Ferrite beads
 - Steel-core toroids
28. Which of the following component package types would be most suitable for use at frequencies above the HF range?
- TO-220
 - Axial lead
 - Radial lead
 - Surface mount

29. What is the efficiency of a photovoltaic cell?
- The output RF power divided by the input DC power
 - The effective payback period
 - The open-circuit voltage divided by the short-circuit current under full illumination
 - The relative fraction of light that is converted to current
30. What logical operation is performed by an exclusive NOR gate?
- It produces logic "0" at its output only if all inputs are logic "0"
 - It produces logic "1" at its output only if all inputs are logic "1"
 - It produces logic "0" at its output if any single input is logic "1"
 - It produces logic "1" at its output if any single input is logic "1"
31. Which of the following describes how the loading and tuning capacitors are to be adjusted when tuning a vacuum tube RF power amplifier that employs a Pi-network output circuit?
- The loading capacitor is set to maximum capacitance and the tuning capacitor is adjusted for minimum allowable plate current
 - The tuning capacitor is set to maximum capacitance and the loading capacitor is adjusted for minimum plate permissible current
 - The loading capacitor is adjusted to minimum plate current while alternately adjusting the tuning capacitor for maximum allowable plate current
 - The tuning capacitor is adjusted for minimum plate current, and the loading capacitor is adjusted for maximum permissible plate current
32. What is a Jones filter as used as part of an HF receiver IF stage?
- An automatic notch filter
 - A variable bandwidth crystal lattice filter
 - A special filter that emphasizes image responses
 - A filter that removes impulse noise
33. What is the main reason to use a charge controller with a solar power system?
- Prevention of battery undercharge
 - Control of electrolyte levels during battery discharge
 - Prevention of battery damage due to overcharge
 - Matching of day and night charge rates
34. What occurs when an excessive amount of signal energy reaches a mixer circuit?
- Spurious mixer products are generated
 - Mixer blanking occurs
 - Automatic limiting occurs
 - A beat frequency is generated
35. Why is an anti-aliasing digital filter required in a digital decimator?
- It removes high-frequency signal components which would otherwise be reproduced as lower frequency components
 - It peaks the response of the decimator, improving bandwidth
 - It removes low frequency signal components to eliminate the need for DC restoration
 - It notches out the sampling frequency to avoid sampling errors

Question 36 pertains to the following graphic:

Figure E7-4



36. What will be the output voltage of the circuit shown in Figure E7-4 if R1 is 1000 ohms, RF is 10,000 ohms, and 0.23 volts DC is applied to the input?

- a. 0.23 volts
- b. 2.3 volts
- c. -0.23 volts
- d. -2.3 volts

37. What type of frequency synthesizer circuit uses a phase accumulator, lookup table, digital to analog converter, and a low-pass anti-alias filter?

- a. A direct digital synthesizer
- b. A hybrid synthesizer
- c. A phase locked loop synthesizer
- d. A diode-switching matrix synthesizer

38. How many levels can an analog-to-digital converter with 8 bit resolution encode?

- a. 8
- b. 8 multiplied by the gain of the input amplifier
- c. 256 divided by the gain of the input amplifier
- d. 256

39. What is meant by deviation ratio?

- a. The ratio of the audio modulating frequency to the center carrier frequency
- b. The ratio of the maximum carrier frequency deviation to the highest audio modulating frequency
- c. The ratio of the carrier center frequency to the audio modulating frequency
- d. The ratio of the highest audio modulating frequency to the average audio modulating frequency

40. Which is the name of a digital code where each preceding or following character changes by only one bit?
- Binary Coded Decimal Code
 - Extended Binary Coded Decimal Interchange Code
 - Excess 3 code
 - Gray code
41. What is considered a good minimum IMD level for an idling PSK signal?
- +10 dB
 - +15 dB
 - 20 dB
 - 30 dB
42. What is meant by antenna bandwidth?
- Antenna length divided by the number of elements
 - The frequency range over which an antenna satisfies a performance requirement
 - The angle between the half-power radiation points
 - The angle formed between two imaginary lines drawn through the element ends
43. What type of computer program technique is commonly used for modeling antennas?
- Graphical analysis
 - Method of Moments
 - Mutual impedance analysis
 - Calculus differentiation with respect to physical properties
44. What is a G5RV antenna?
- A multi-band dipole antenna fed with coax and a balun through a selected length of open wire transmission line
 - A multi-band trap antenna
 - A phased array antenna consisting of multiple loops
 - A wide band dipole using shorted coaxial cable for the radiating elements and fed with a 4:1 balun
45. What is the function of a loading coil used as part of an HF mobile antenna?
- To increase the SWR bandwidth
 - To lower the losses
 - To lower the Q
 - To cancel capacitive reactance
46. Which of these matching systems is an effective method of connecting a 50 ohm coaxial cable feed line to a grounded tower so it can be used as a vertical antenna?
- Double-bazooka match
 - Hairpin match
 - Gamma match
 - All of these choices are correct

47. What is the approximate physical length of a solid polyethylene dielectric coaxial transmission line that is electrically one-quarter wavelength long at 7.2 MHz?
- a. 10 meters
 - b. 6.9 meters
 - c. 24 meters
 - d. 50 meters
48. What third family of circles is often added to a Smith chart during the process of solving problems?
- a. Standing wave ratio circles
 - b. Antenna-length circles
 - c. Coaxial-length circles
 - d. Radiation-pattern circles
49. How can the output voltage of a multiple turn receiving loop antenna be increased?
- a. By reducing the permeability of the loop shield
 - b. By increasing the number of wire turns in the loop and reducing the area of the loop structure
 - c. By winding adjacent turns in opposing directions
 - d. By increasing either the number of wire turns in the loop or the area of the loop structure or both
50. Which insulating material commonly used as a thermal conductor for some types of electronic devices is extremely toxic if broken or crushed and the particles are accidentally inhaled?
- a. Mica
 - b. Zinc oxide
 - c. Beryllium Oxide
 - d. Uranium Hexafluoride

Test #9 Answer Key and Explanations

1. A: If your digital message forwarding station inadvertently forwards a communication that violates FCC rules, the first thing you should do is stop forwarding the message.
2. C: Any FCC-licensed amateur station certified by the responsible civil defense organization for the area served may be operated under RACES rules.
3. D: An automatically controlled repeater operating below 30 MHz may operate between 29.500 MHz and 29.700 MHz.
4. B: The 70 cm and 13 cm amateur service bands have frequencies available for space stations.
5. A: A VE who fraudulently administers or certifies an examination may be subject to revocation of his or her amateur station license grant and suspension of his or her amateur operator license grant.
6. D: When transmitting spread spectrum emission, the station must not cause harmful interference to other stations employing other authorized emissions, the transmitting station must be in an area regulated by the FCC or in a country that permits SS emissions, and the transmission must not be used to obscure the meaning of any communication.
7. A: The terms L band and S band specify the 23 centimeter and 13 centimeter bands, respectively, with regard to satellite communications.
8. D: The only hardware required to decode SSTV using Digital Radio Mondiale (DRM) is a receiver with SSB capability and a suitable computer.
9. C: Standard wireless routers running custom software are commonly used to implement ham radio mesh networks.
10. D: 300 baud packets are faster than PSK31, 170 Hz shift, 45 baud RTTY, and AMTOR under clear communication conditions.
11. D: PSK31 uses variable-length coding for bandwidth efficiency.
12. C: The 28 MHz – 148 MHz range is better suited for meteor scatter communications than 1.8 MHz – 1.9 MHz, 10 MHz – 14 MHz, or 220 MHz – 450 MHz.
13. A: Sporadic E propagation most likely to occur around the solstices, especially the summer solstice.
14. C: An X3 flare is twice as great as an X2 flare.
15. B: When using a computer's soundcard input to digitize signals, the highest frequency signal that can be digitized without aliasing is one-half the sample rate.
16. D: If the current reading on an RF ammeter placed in series with the antenna feed line of a transmitter increases as the transmitter is tuned to resonance, it indicates there is more power going into the antenna.

17. C: It is a good reason to select a high frequency for the design of the IF in a conventional HF or VHF communications receiver because it makes it easier for front-end circuitry to eliminate image responses.
18. C: The purpose of the preselector in a communications receiver is to increase rejection of unwanted signals.
19. C: When using an IF noise blanker, nearby signals may appear to be excessively wide even if they meet emission standards.
20. C: The Q of an RLC parallel resonant circuit is calculated by dividing the resistance by the reactance of either the inductance or capacitance.
21. D: In a capacitor, current leads voltage by 90 degrees.
22. A: When using rectangular coordinates to graph the impedance of a circuit, the horizontal axis represents the resistive component.
23. B: Reactive power in an AC circuit that has both ideal inductors and ideal capacitors is repeatedly exchanged between the associated magnetic and electric fields, but is not dissipated.
24. A: A depletion-mode FET is an FET that exhibits a current flow between source and drain when no gate voltage is applied.
25. C: Point contact diodes are used as RF detectors.
26. B: A PLD is a programmable collection of logic gates and circuits in a single integrated circuit.
27. C: Ferrite beads are commonly used as VHF and UHF parasitic suppressors at the input and output terminals of transistor HF amplifiers.
28. D: Components in surface mount packaging are most suitable for use at frequencies above the HF range.
29. D: The efficiency of a photovoltaic cell is the relative fraction of light that is converted to current.
30. C: Exclusive NOR gates produce logic "0" at their output if any single input is logic "1".
31. D: When tuning a vacuum tube RF power amplifier that employs a Pi-network output circuit, the tuning capacitor is adjusted for minimum plate current, and the loading capacitor is adjusted for maximum permissible plate current.
32. B: A Jones filter as used as part of an HF receiver IF stage is a variable bandwidth crystal lattice filter.
33. C: The main reason to use a charge controller with a solar power system is to prevent battery damage due to overcharging.
34. A: When an excessive amount of signal energy reaches a mixer circuit, spurious mixer products are generated.
35. A: An anti-aliasing digital filter is required in a digital decimator to remove high-frequency signal components which would otherwise be reproduced as lower frequency components.

36. D: The output voltage of the circuit shown in Figure E7-4 when R1 is 1000 ohms, RF is 10,000 ohms, and 0.23 volts DC is applied to the input is -2.3 volts.
37. A: A direct digital synthesizer uses a phase accumulator, lookup table, digital to analog converter, and a low-pass anti-alias filter.
38. D: An analog-to-digital converter with 8 bit resolution can encode 256 levels.
39. B: Deviation ratio is the ratio of the maximum carrier frequency deviation to the highest audio modulating frequency.
40. D: In Gray code, each preceding or following character changes by only one bit.
41. D: A good minimum IMD level for an idling PSK signal is -30 dB.
42. B: Antenna bandwidth is the frequency range over which an antenna satisfies a performance requirement.
43. B: Method of Moments is a type of computer program technique commonly used for modeling antennas.
44. A: A G5RV antenna is a multi-band dipole antenna fed with coax and a balun through a selected length of open wire transmission line.
45. D: Loading coils used in HF mobile antennas cancel capacitive reactance.
46. C: Gamma match is an effective method of connecting a 50 ohm coaxial cable feed line to a grounded tower so it can be used as a vertical antenna.
47. B: A solid polyethylene dielectric coaxial transmission line that is electrically one-quarter wavelength long at 7.2 MHz has an approximate physical length of 6.9 meters.
48. A: Standing wave ratio circles are often added to a Smith chart during the process of solving problems.
49. D: The output voltage of a multiple turn receiving loop antenna can be increased by increasing either the number of wire turns in the loop or the area of the loop structure or both.
50. C: Beryllium Oxide is extremely toxic if broken or crushed and the particles are accidentally inhaled.

Test #10 Practice Questions

1. If an amateur station is installed aboard a ship or aircraft, what condition must be met before the station is operated?
 - a. Its operation must be approved by the master of the ship or the pilot in command of the aircraft
 - b. The amateur station operator must agree not to transmit when the main radio of the ship or aircraft is in use
 - c. The amateur station must have a power supply that is completely independent of the main ship or aircraft power supply
 - d. The amateur operator must have an FCC Marine or Aircraft endorsement on his or her amateur license
2. What frequencies are authorized to an amateur station operating under RACES rules?
 - a. All amateur service frequencies authorized to the control operator
 - b. Specific segments in the amateur service MF, HF, VHF and UHF bands
 - c. Specific local government channels
 - d. Military Auxiliary Radio System (MARS) channels
3. What types of amateur stations may automatically retransmit the radio signals of other amateur stations?
 - a. Only beacon, repeater or space stations
 - b. Only auxiliary, repeater or space stations
 - c. Only earth stations, repeater stations or model craft
 - d. Only auxiliary, beacon or space stations
4. Which amateur stations are eligible to be telecommand stations?
 - a. Any amateur station designated by NASA
 - b. Any amateur station so designated by the space station licensee, subject to the privileges of the class of operator license held by the control operator
 - c. Any amateur station so designated by the ITU
 - d. All of these choices are correct
5. What must the administering VEs do after the administration of a successful examination for an amateur operator license?
 - a. They must collect and send the documents to the NCVEC for grading
 - b. They must collect and submit the documents to the coordinating VEC for grading
 - c. They must submit the application document to the coordinating VEC according to the coordinating VEC instructions
 - d. They must collect and send the documents to the FCC according to instructions
6. What is the maximum permitted transmitter peak envelope power for an amateur station transmitting spread spectrum communications?
 - a. 1 W
 - b. 1.5 W
 - c. 10 W
 - d. 1.5 kW

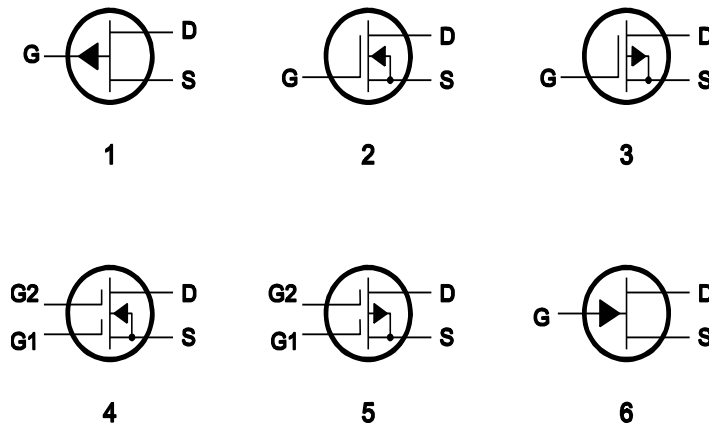
7. Why may the received signal from an amateur satellite exhibit a rapidly repeating fading effect?
- Because the satellite is spinning
 - Because of ionospheric absorption
 - Because of the satellite's low orbital altitude
 - Because of the Doppler Effect
8. Which of the following is an acceptable bandwidth for Digital Radio Mondiale (DRM) based voice or SSTV digital transmissions made on the HF amateur bands?
- 3 KHz
 - 10 KHz
 - 15 KHz
 - 20 KHz
9. Why might a DX station state that they are listening on another frequency?
- Because the DX station may be transmitting on a frequency that is prohibited to some responding stations
 - To separate the calling stations from the DX station
 - To improve operating efficiency by reducing interference
 - All of these choices are correct
10. How can an APRS station be used to help support a public service communications activity?
- An APRS station with an emergency medical technician can automatically transmit medical data to the nearest hospital
 - APRS stations with General Personnel Scanners can automatically relay the participant numbers and time as they pass the check points
 - An APRS station with a GPS unit can automatically transmit information to show a mobile station's position during the event
 - All of these choices are correct
11. Which of these digital modes has the narrowest bandwidth?
- MFSK16
 - 170 Hz shift, 45 baud RTTY
 - PSK31
 - 300-baud packet
12. Which type of atmospheric structure can create a path for microwave propagation?
- The jet stream
 - Temperature inversion
 - Wind shear
 - Dust devil
13. What is the cause of gray-line propagation?
- At midday, the Sun super heats the ionosphere causing increased refraction of radio waves
 - At twilight and sunrise, D-layer absorption is low while E-layer and F-layer propagation remains high
 - In darkness, solar absorption drops greatly while atmospheric ionization remains steady
 - At mid-afternoon, the Sun heats the ionosphere decreasing radio wave refraction and the MUF

14. What does the 304A solar parameter measure?
- The ratio of X-Ray flux to radio flux, correlated to sunspot number
 - UV emissions at 304 angstroms, correlated to solar flux index
 - The solar wind velocity at 304 degrees from the solar equator, correlated to solar activity
 - The solar emission at 304 GHz, correlated to X-Ray flare levels
15. Which of the following displays multiple digital signal states simultaneously?
- Network analyzer
 - Bit error rate tester
 - Modulation monitor
 - Logic analyzer
16. Which of the following describes a method to measure intermodulation distortion in an SSB transmitter?
- Modulate the transmitter with two non-harmonically related radio frequencies and observe the RF output with a spectrum analyzer
 - Modulate the transmitter with two non-harmonically related audio frequencies and observe the RF output with a spectrum analyzer
 - Modulate the transmitter with two harmonically related audio frequencies and observe the RF output with a peak reading wattmeter
 - Modulate the transmitter with two harmonically related audio frequencies and observe the RF output with a logic analyzer
17. Which of the following is a desirable amount of selectivity for an amateur RTTY HF receiver?
- 100 Hz
 - 300 Hz
 - 6000 Hz
 - 2400 Hz
18. What does a third-order intercept level of 40 dBm mean with respect to receiver performance?
- Signals less than 40 dBm will not generate audible third-order intermodulation products
 - The receiver can tolerate signals up to 40 dB above the noise floor without producing third-order intermodulation products
 - A pair of 40 dBm signals will theoretically generate a third-order intermodulation product with the same level as the input signals
 - A pair of 1 mW input signals will produce a third-order intermodulation product which is 40 dB stronger than the input signal
19. What is a common characteristic of interference caused by a touch controlled electrical device?
- The interfering signal sounds like AC hum on an AM receiver or a carrier modulated by 60 Hz hum on a SSB or CW receiver
 - The interfering signal may drift slowly across the HF spectrum
 - The interfering signal can be several kHz in width and usually repeats at regular intervals across a HF band
 - All of these choices are correct

20. How is the Q of an RLC series resonant circuit calculated?
- Reactance of either the inductance or capacitance divided by the resistance
 - Reactance of either the inductance or capacitance times the resistance
 - Resistance divided by the reactance of either the inductance or capacitance
 - Reactance of the inductance times the reactance of the capacitance
21. What is the relationship between the current through an inductor and the voltage across an inductor?
- Voltage leads current by 90 degrees
 - Current leads voltage by 90 degrees
 - Voltage and current are 180 degrees out of phase
 - Voltage and current are in phase
22. When using rectangular coordinates to graph the impedance of a circuit, what does the vertical axis represent?
- Resistive component
 - Reactive component
 - The sum of the reactive and resistive components
 - The difference between the resistive and reactive components
23. How can the true power be determined in an AC circuit where the voltage and current are out of phase?
- By multiplying the apparent power times the power factor
 - By dividing the reactive power by the power factor
 - By dividing the apparent power by the power factor
 - By multiplying the reactive power times the power factor

Question 24 pertains to the following graphic:

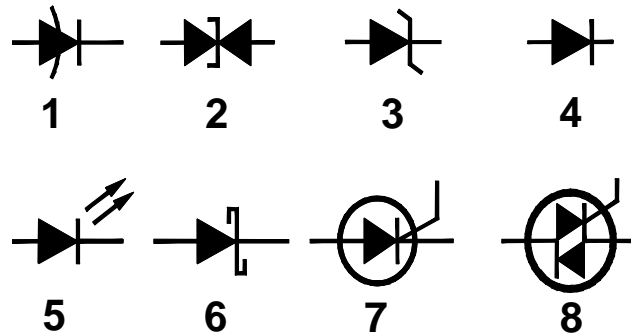
Figure E6-2



24. In Figure E6-2, what is the schematic symbol for an N-channel dual-gate MOSFET?
- 2
 - 4
 - 5
 - 6

Question 25 pertains to the following graphic:

Figure E6-3

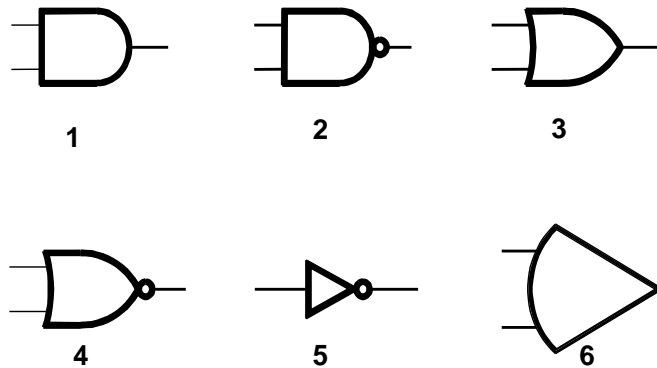


25. In Figure E6-3, what is the schematic symbol for a light-emitting diode?

- a. 1
- b. 5
- c. 6
- d. 7

Question 26 pertains to the following graphic:

Figure E6-5



26. In Figure E6-5, what is the schematic symbol for a NOR gate?

- a. 1
- b. 2
- c. 3
- d. 4

27. What is a primary advantage of using a toroidal core instead of a solenoidal core in an inductor?

- a. Toroidal cores confine most of the magnetic field within the core material
- b. Toroidal cores make it easier to couple the magnetic energy into other components
- c. Toroidal cores exhibit greater hysteresis
- d. Toroidal cores have lower Q characteristics

28. What is the packaging technique in which leadless components are soldered directly to circuit boards?

- a. Direct soldering
- b. Virtual lead mounting
- c. Stripped lead
- d. Surface mount

29. What is the most common type of photovoltaic cell used for electrical power generation?

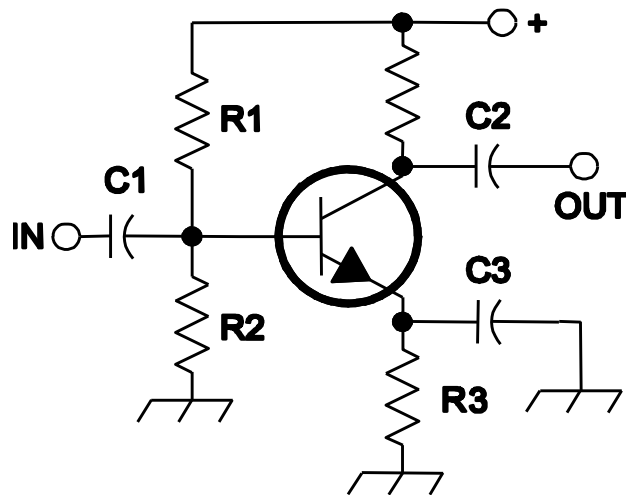
- a. Selenium
- b. Silicon
- c. Cadmium Sulfide
- d. Copper oxide

30. What is a truth table?

- a. A table of logic symbols that indicate the high logic states of an op-amp
- b. A diagram showing logic states when the digital device output is true
- c. A list of inputs and corresponding outputs for a digital device
- d. A table of logic symbols that indicate the logic states of an op-amp

Question 31 pertains to the following graphic:

Figure E7-1



31. In Figure E7-1, what is the purpose of R1 and R2?

- a. Load resistors
- b. Fixed bias
- c. Self bias
- d. Feedback

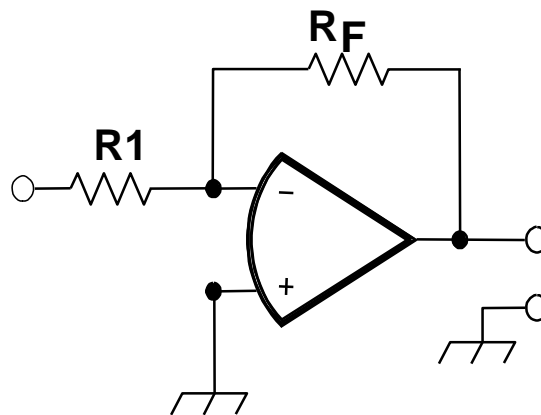
32. Which of the following filters would be the best choice for use in a 2 meter repeater duplexer?

- a. A crystal filter
- b. A cavity filter
- c. A DSP filter
- d. An L-C filter

33. What is the primary reason that a high-frequency switching type high voltage power supply can be both less expensive and lighter in weight than a conventional power supply?
- The inverter design does not require any output filtering
 - It uses a diode bridge rectifier for increased output
 - The high frequency inverter design uses much smaller transformers and filter components for an equivalent power output
 - It uses a large power factor compensation capacitor to create free power from the unused portion of the AC cycle
34. How does a diode detector function?
- By rectification and filtering of RF signals
 - By breakdown of the Zener voltage
 - By mixing signals with noise in the transition region of the diode
 - By sensing the change of reactance in the diode with respect to frequency
35. What aspect of receiver analog-to-digital conversion determines the maximum receive bandwidth of a Direct Digital Conversion SDR?
- Sample rate
 - Sample width in bits
 - Sample clock phase noise
 - Processor latency

Question 36 pertains to the following graphic:

Figure E7-4



36. What absolute voltage gain can be expected from the circuit in Figure E7-4 when R1 is 1800 ohms and RF is 68 kilohms?
- 1
 - 0.03
 - 38
 - 76

37. What information is contained in the lookup table of a direct digital frequency synthesizer?
- The phase relationship between a reference oscillator and the output waveform
 - The amplitude values that represent a sine-wave output
 - The phase relationship between a voltage-controlled oscillator and the output waveform
 - The synthesizer frequency limits and frequency values stored in the radio memories
38. What is the purpose of a low pass filter used in conjunction with a digital-to-analog converter?
- Lower the input bandwidth to increase the effective resolution
 - Improve accuracy by removing out of sequence codes from the input
 - Remove harmonics from the output caused by the discrete analog levels generated
 - All of these choices are correct
39. What describes frequency division multiplexing?
- The transmitted signal jumps from band to band at a predetermined rate
 - Two or more information streams are merged into a baseband, which then modulates the transmitter
 - The transmitted signal is divided into packets of information
 - Two or more information streams are merged into a digital combiner, which then pulse position modulates the transmitter
40. What is an advantage of Gray code in digital communications where symbols are transmitted as multiple bits?
- It increases security
 - It has more possible states than simple binary
 - It has more resolution than simple binary
 - It facilitates error detection
41. What are some of the differences between the Baudot digital code and ASCII?
- Baudot uses 4 data bits per character, ASCII uses 7 or 8; Baudot uses 1 character as a letters/figures shift code, ASCII has no letters/figures code
 - Baudot uses 5 data bits per character, ASCII uses 7 or 8; Baudot uses 2 characters as letters/figures shift codes, ASCII has no letters/figures shift code
 - Baudot uses 6 data bits per character, ASCII uses 7 or 8; Baudot has no letters/figures shift code, ASCII uses 2 letters/figures shift codes
 - Baudot uses 7 data bits per character, ASCII uses 8; Baudot has no letters/figures shift code, ASCII uses 2 letters/figures shift codes
42. How is antenna efficiency calculated?
- $(\text{radiation resistance} / \text{transmission resistance}) \times 100$ per cent
 - $(\text{radiation resistance} / \text{total resistance}) \times 100$ per cent
 - $(\text{total resistance} / \text{radiation resistance}) \times 100$ per cent
 - $(\text{effective radiated power} / \text{transmitter output}) \times 100$ percent
43. What is the principle of a Method of Moments analysis?
- A wire is modeled as a series of segments, each having a uniform value of current
 - A wire is modeled as a single sine-wave current generator
 - A wire is modeled as a series of points, each having a distinct location in space
 - A wire is modeled as a series of segments, each having a distinct value of voltage across it

44. Which of the following describes a Zepp antenna?
- A dipole constructed from zip cord
 - An end fed dipole antenna
 - An omni-directional antenna commonly used for satellite communications
 - A vertical array capable of quickly changing the direction of maximum radiation by changing phasing lines
45. What happens to feed point impedance at the base of a fixed length HF mobile antenna as the frequency of operation is lowered?
- The radiation resistance decreases and the capacitive reactance decreases
 - The radiation resistance decreases and the capacitive reactance increases
 - The radiation resistance increases and the capacitive reactance decreases
 - The radiation resistance increases and the capacitive reactance increases
46. Which of these choices is an effective way to match an antenna with a 100 ohm feed point impedance to a 50 ohm coaxial cable feed line?
- Connect a 1/4-wavelength open stub of 300 ohm twin-lead in parallel with the coaxial feed line where it connects to the antenna
 - Insert a 1/2 wavelength piece of 300 ohm twin-lead in series between the antenna terminals and the 50 ohm feed cable
 - Insert a 1/4-wavelength piece of 75 ohm coaxial cable transmission line in series between the antenna terminals and the 50 ohm feed cable
 - Connect 1/2 wavelength shorted stub of 75 ohm cable in parallel with the 50 ohm cable where it attaches to the antenna
47. What impedance does a 1/8 wavelength transmission line present to a generator when the line is shorted at the far end?
- A capacitive reactance
 - The same as the characteristic impedance of the line
 - An inductive reactance
 - The same as the input impedance to the final generator stage
48. What do the arcs on a Smith chart represent?
- Frequency
 - SWR
 - Points with constant resistance
 - Points with constant reactance
49. What characteristic of a cardioid pattern antenna is useful for direction finding?
- A very sharp peak
 - A very sharp single null
 - Broad band response
 - High-radiation angle

50. What toxic material may be present in some electronic components such as high voltage capacitors and transformers?

- a. Polychlorinated Biphenyls
- b. Polyethylene
- c. Polytetrafluorethylene
- d. Polymorphic silicon

Test #10 Answer Key and Explanations

1. A: Amateur stations aboard ships or aircraft do not need special endorsement so long as permission is obtained from the captain or pilot of the craft, and all applicable rules are followed.
2. A: An amateur station operating under RACES rules may use all amateur service frequencies authorized to the control operator.
3. B: Only auxiliary, repeater or space stations may automatically retransmit the radio signals of other amateur stations.
4. B: Any amateur station so designated by the space station licensee is eligible to be a telecommand station, subject to the privileges of the class of operator license held by the control operator.
5. C: The administering VEs must submit the application document to the coordinating VEC according to the coordinating VEC's instructions after the administration of a successful examination for an amateur operator license.
6. C: The maximum permitted transmitter peak envelope power for an amateur station transmitting spread spectrum communications is 10 W.
7. A: The received signal from an amateur satellite may exhibit a rapidly repeating fading effect because the satellite is spinning.
8. A: 3 KHz is an acceptable bandwidth for Digital Radio Mondiale (DRM) based voice or SSTV digital transmissions made on the HF amateur bands.
9. D: A DX station may state that they are listening on another frequency for a number of reasons, including because they may be transmitting on a frequency that is prohibited to some responding stations, to separate the calling stations from the DX station, and to improve operating efficiency by reducing interference.
10. C: An APRS station can help support a public service communications activity by automatically transmitting information to show a mobile station's position during the event.
11. C: PSK31 has lower bandwidth than MFSK16, 170 Hz shift, 45 baud RTTY, and 300-baud packets.
12. B: Temperature inversion can create a path for microwave propagation.
13. B: The cause of gray-line propagation is low D-layer absorption and high E-layer and F-layer propagation at twilight and sunrise.
14. B: The 304A solar parameter measures UV emissions at 304 angstroms, correlated to solar flux index.
15. D: A logic analyzer displays multiple digital signal states simultaneously.
16. B: Intermodulation distortion in an SSB transmitter can be measured by modulating the transmitter with two non-harmonically related audio frequencies and observing the RF output with a spectrum analyzer.
17. B: 300 Hz is a desirable amount of selectivity for an amateur RTTY HF receiver.

18. C: A third-order intercept level of 40 dBm means that a pair of 40 dBm signals will theoretically generate a third-order intermodulation product with the same level as the input signals.
19. D: Touch-controlled electrical devices may cause interference that sounds like AC hum on an AM receiver or a carrier modulated by 60 Hz hum on a SSB or CW receiver, interference that drifts slowly across the HF spectrum, and interference that can be several kHz in width and repeats at regular intervals across a HF band.
20. A: The Q of an RLC series resonant circuit is calculated by dividing the reactance of either the inductance or capacitance by the resistance.
21. A: In an inductor, voltage leads current by 90 degrees.
22. B: When using rectangular coordinates to graph the impedance of a circuit, the vertical axis represents the reactive component.
23. A: True power in an out-of-phase AC circuit can be determined by multiplying the apparent power times the power factor.
24. B: In Figure E6-2, the schematic symbol for an N-channel dual-gate MOSFET is 4.
25. B: In Figure E6-3, the schematic symbol for a light-emitting diode is 5.
26. D: In Figure E6-5, the schematic symbol for a NOR gate is 4.
27. A: Toroidal cores confine most of the magnetic field within the core material, while solenoidal cores do not.
28. D: Surface mount is the packaging technique in which leadless components are soldered directly to circuit boards.
29. B: The most common type of photovoltaic cell used for electrical power generation is silicon.
30. C: A truth table is a list of inputs and corresponding outputs for a digital device.
31. B: In Figure E7-1, R1 and R2 are used as a fixed bias.
32. B: A cavity filter would be the best choice for use in a 2 meter repeater duplexer.
33. C: The primary reason that a high-frequency switching type high voltage power supply can be both less expensive and lighter in weight than a conventional power supply is that the high frequency inverter design uses much smaller transformers and filter components for an equivalent power output.
34. A: A diode detector functions by rectifying and filtering of RF signals.
35. A: Sample rate determines the maximum receive bandwidth of a Direct Digital Conversion SDR.
36. C: A voltage gain of 38 can be expected from the circuit in Figure E7-4 when R1 is 1800 ohms and RF is 68 kilohms.
37. B: The amplitude values that represent a sine-wave output are contained in the lookup table of a direct digital frequency synthesizer.

38. C: A low pass filter used in conjunction with a digital-to-analog converter serves to remove harmonics from the output caused by the discrete analog levels generated.
39. B: Frequency division multiplexing is when two or more information streams are merged into a baseband, which then modulates the transmitter.
40. D: An advantage of Gray code in digital communications is that it facilitates error detection.
41. B: Baudot uses 5 data bits per character, ASCII uses 7 or 8; Baudot uses 2 characters as letters/figures shift codes, ASCII has no letters/figures shift code.
42. B: Antenna efficiency is calculated by (radiation resistance / total resistance) x 100 per cent.
43. A: In Method of Moments analysis, a wire is modeled as a series of segments, each having a uniform value of current.
44. B: A Zepp antenna is an end-fed dipole antenna.
45. B: As the frequency of operation is lowered for a fixed-length HF mobile antenna, the radiation resistance decreases and the capacitive reactance increases.
46. C: Inserting a 1/4-wavelength piece of 75 ohm coaxial cable transmission line in series between the antenna terminals and the 50 ohm feed cable would be an effective way to match their impedances.
47. C: A 1/8 wavelength transmission line presents an inductive reactance to a generator when the line is shorted at the far end.
48. D: The arcs on a Smith chart represent points with constant reactance.
49. B: The very sharp single null part of a cardioid pattern antenna is useful for direction finding.
50. A: Polychlorinated biphenyls may be present in some electronic components such as high voltage capacitors and transformers.

Additional Bonus Material

Due to our efforts to try to keep this book to a manageable length, we've created a link that will give you access to all of your additional bonus material.

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