2020-2024 Amateur Extra Class
FCC Element 4 Question Pool
Effective 7/01/2020 – 6/30/2024

SUBELEMENT E4 – AMATEUR PRACTICES [5 Exam Questions - 5 Groups]

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

E4A01
Which of the following limits the highest frequency signal that can be accurately displayed on a digital oscilloscope?
A. Sampling rate of the analog-to-digital converter
B. Amount of memory
C. Q of the circuit
D. All these choices are correct
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E4A02
Which of the following parameters does 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
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E4A03
Which of the following test instruments is used to display spurious signals and/or intermodulation distortion products generated by an SSB transmitter?
A. A wattmeter
B. A spectrum analyzer
C. A logic analyzer
D. A time-domain reflectometer
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E4A04
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
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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
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What is the effect of aliasing on a digital oscilloscope caused by setting the time base too slow?
A. A false, jittery low-frequency version of the signal is displayed
B. All signals will have a DC offset
C. Calibration of the vertical scale is no longer valid
D. Excessive blanking occurs, which prevents display of the signal
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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 these choices are correct
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Which of the following measures SWR?
A. A spectrum analyzer
B. A Q meter
C. An ohmmeter
D. An antenna analyzer
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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 these choices are correct
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Which of the following displays multiple digital signal states simultaneously?
A. Network analyzer
B. Bit error rate tester
C. Modulation monitor
D. Logic analyzer
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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
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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
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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
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Which S parameter is equivalent to forward gain?
A. S11
B. S12
C. S21
D. S22
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Which S parameter represents input port return loss or reflection coefficient (equivalent to VSWR)?
A. S11
B. S12
C. S21
D. S22
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What three test loads are used to calibrate an 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
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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
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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
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Which of the following can be used to measure the Q of 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
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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
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Which of the following methods measures intermodulation distortion in an SSB transmitter?
A. Modulate the transmitter using two RF signals having non-harmonically related frequencies and observe the RF output with a spectrum analyzer
B. Modulate the transmitter using two AF signals having non-harmonically related frequencies and observe the RF output with a spectrum analyzer
C. Modulate the transmitter using two AF signals having harmonically related frequencies and observe the RF output with a peak reading wattmeter
D. Modulate the transmitter using two RF signals having harmonically related frequencies and observe the RF output with a logic analyzer

Which of the following can be measured with a vector network analyzer?
A. Input impedance
B. Output impedance
C. Reflection coefficient
D. All these choices are correct

E4C Receiver performance characteristics: phase noise, noise floor, image rejection, MDS, signal-to-noise ratio, noise figure, reciprocal mixing; selectivity; effects of SDR receiver non-linearity; use of attenuators at low frequencies

What is an effect of excessive phase noise in a receiver's local oscillator?
A. It limits the receiver's ability to receive strong signals
B. It can affect the receiver's frequency calibration
C. It decreases receiver third-order intercept point
D. It can combine with strong signals on nearby frequencies to generate interference
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Which of the following receiver circuits can be effective in eliminating interference from strong out-of-band signals?
A. A front-end filter or pre-selector
B. A narrow IF filter
C. A notch filter
D. A properly adjusted product detector
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What is the term for the suppression in an FM receiver of one signal by another stronger signal on the same frequency?
A. Desensitization
B. Cross-modulation interference
C. Capture effect
D. Frequency discrimination
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What is the noise figure of a receiver?
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
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What does a receiver noise floor of -174 dBm represent?
A. The minimum detectable signal as a function of receive frequency
B. The theoretical noise in a 1 Hz bandwidth 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

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
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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
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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
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Which of the following choices is a good reason for selecting a high frequency for the design of the IF in a superheterodyne 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
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What is an advantage of having a variety of receiver IF bandwidths from which to select?
A. The noise figure of the RF amplifier can be adjusted to match the modulation type, thus increasing receiver sensitivity
B. Receiver power consumption can be reduced when wider bandwidth is not required
C. Receive bandwidth can be set to match the modulation bandwidth, maximizing signal-to-noise ratio and minimizing interference
D. Multiple frequencies can be received simultaneously if desired
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Why can an attenuator be used to reduce receiver overload on the lower frequency HF bands with little or no impact on signal-to-noise ratio?
A. The attenuator has a low-pass filter to increase the strength of lower frequency signals
B. The attenuator has a noise filter to suppress interference
C. Signals are attenuated separately from the noise
D. Atmospheric noise is generally greater than internally generated noise even after attenuation
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Which of the following has the largest effect on an SDR receiver's dynamic range?
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
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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 these choices are correct
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What transmit frequency might generate an image response signal in a receiver tuned to 14.300 MHz and that uses a 455 kHz IF frequency?
A. 13.845 MHz
B. 14.755 MHz
C. 14.445 MHz
D. 15.210 MHz
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What is reciprocal mixing?
A. Two out-of-band signals mixing to generate an in-band spurious signal
B. In-phase signals cancelling in a mixer resulting in loss of receiver sensitivity
C. Two digital signals combining from alternate time slots
D. Local oscillator phase noise mixing with adjacent strong signals to create interference to desired signals
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E4D Receiver performance characteristics: blocking dynamic range; intermodulation and cross-modulation interference; third-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 that will cause 1 dB of gain compression
B. The minimum difference in dB between the levels of two FM signals that 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
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Which of the following describes problems caused by poor dynamic range in a receiver?
A. Spurious signals caused by cross-modulation 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
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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
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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 repeater's transmitter
C. Utilizing a Class C final amplifier
D. Utilizing a Class D final amplifier
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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
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What is the term for spurious signals generated by the combination of two or more signals in a non-linear device or circuit?
A. Amplifier desensitization
B. Neutralization
C. Adjacent channel interference
D. Intermodulation
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Which of the following reduces 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
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What causes intermodulation in an electronic circuit?
A. Too little gain
B. Lack of neutralization
C. Nonlinear circuits or devices
D. Positive feedback
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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 signals outside the desired band
D. To allow selection of the optimum RF amplifier device
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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 input signals will theoretically generate a third-order intermodulation product that has the same output amplitude as either of the input signals
D. A pair of 1 mW input signals will produce a third-order intermodulation product that is 40 dB stronger than the input signal
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Why are odd-order intermodulation products, created within a receiver, of particular interest compared to other products?
A. Odd-order products of two signals in the band of interest are also likely to be within the band
B. Odd-order products overload the IF filters
C. Odd-order products are an indication of poor image rejection
D. Odd-order intermodulation produces three products for every input signal within the band of interest
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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
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E4E Noise suppression and interference: system noise; electrical appliance noise; line noise; locating noise sources; DSP noise reduction; noise blankers; grounding for signals; common mode currents

What problem can occur when using an automatic notch filter (ANF) to remove interfering carriers while receiving CW signals?
A. Removal of the CW signal as well as the interfering carrier
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
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Which of the following types of noise can often be reduced with a digital signal processing noise filter?
A. Broadband white noise
B. Ignition noise
C. Power line noise
D. All these choices are correct
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Which of the following signals might a receiver noise blanker be able to remove from desired signals?
A. Signals that are constant at all IF levels
B. Signals that appear across a wide bandwidth
C. Signals that appear at one IF but not another
D. Signals that have a sharply peaked frequency distribution
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E4E04
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
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E4E05
How can radio frequency interference from an AC 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
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E4E06
What is one type of electrical interference that might be caused by 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
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E4E07
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
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E4E08
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
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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
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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 these choices are correct
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What could cause local AM broadcast band signals to combine to generate spurious signals in the MF or HF bands?
A. One or more of the broadcast stations is transmitting an over-modulated signal
B. Nearby corroded metal joints are mixing and re-radiating the broadcast signals
C. You are receiving skywave signals from a distant station
D. Your station receiver IF amplifier stage is defective
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