

# Amateur Radio Service Technician Class

Wendover Exam Preparation Class

February 2019

Session 1

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These slides are uploaded to my website

<https://k7ojl.com/class-course-materials/technician-class-materials/>

just before class each week.

Depending on how the class goes, they may get updated after the class.

# Class Overview

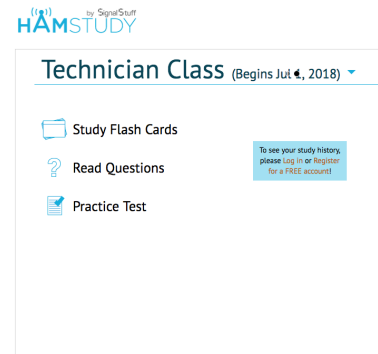
- Introductions
- Getting Started With This Class
- What is the Amateur Radio Service
- Operating Practices
- Call Signs
- The Technician Exam
- Frequencies and Band Plans
- Your Radio and Repeaters
- Emergency Operations
- Nets and Net Operations

# Introductions



# Getting Started

- This class will teach the fundamentals and information that the Amateur Radio Operator needs to know.
  - It doesn't "teach the test".
- [www.hamstudy.org](http://www.hamstudy.org) is where you'll study the actual test questions and take practice tests.
  - If you will spend three hours/week in class and 2-3 hours/week on [hamstudy.org](http://hamstudy.org), you will pass the test.



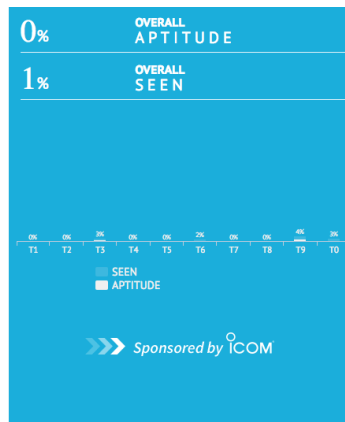
# hamstudy.org

T3  
C01

What is the ability to store energy in an electric field called?

- A. Resistance
- B. Capacitance
- C. Tolerance
- D. Inductance

*type or click response*



# **The Amateur Radio Service**

# The Amateur Radio Service

Amateur radio (also known as “ham radio”) services are regulated under Part 97 of the FCC rules. Amateur radio operators are licensed users who operate radio communications as a hobby or a voluntary service running within amateur radio frequencies allocated by the FCC.

Amateur, in this case, means “non-professional”, or in other words, unpaid.

There are more than 800,000 ham radio operators in the US.



The amateur service is for qualified persons of all ages who are interested in radio technique solely with a personal aim and without pecuniary interest ([fcc.gov](http://fcc.gov)).

# License Classes

- Currently being issued:
  - Technician Class
  - General Class
  - Amateur Extra Class
- Previously issued, some still operating
  - Novice class
  - Advanced class

# Operating Practices

# Operating Practices

- As a station licensee, you are the **Control Operator**
  - You can designate another licensed operator as a control operator
- You must identify every ten minutes and at the end of a communication
- Phonetic alphabet is encouraged (but not required)



Tactical callsigns ... end the communication with the control operator's FCC callsign

# Phonetic Alphabet

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



# Operator Practices (continued)

- You may communicate with any other country EXCEPT where that country has notified the US Government that communication is prohibited.
- You may communicate about amateur radio or personal characteristics. No Business!

# 3rd-Party Communications

A third-party communication is a message from a control operator to another station's control operator on behalf of another person.

Specifically, it is a communication by amateur radio on behalf of a non-licensed person.

- Permitted between countries ONLY where a 3rd-party agreement is in place between those two countries.
- Santa Claus nets each December are an example of 3rd-party communications

# Some Important Rules

- No obscenities
- No interfering with other radio communications
- No broadcasting — communications must be amongst two or more licensed parties
- No “coded” or “encrypted” communications
  - Except when sending control commands to a space station or radio controlled craft
- No music ... even background music
- No sales, except incidental sales of amateur radio equipment
- You must let the FCC in to examine your station
- You must keep your address current in the FCC database

# Call Signs

# Amateur Radio Call Signs

- Sequentially issued by the FCC
- Will be in the FCC database within 10-12 days of passing the examination
- Format is 1-2 letters followed by a digit followed by 1-3 letters
  - Technicians are limited to 1x3 or 2x3 callsigns
- Valid for 10 years



**Not a Valid Callsign!**

# Call Signs

- First character must be A, K, N, or W
  - As allowed by the IARU
- Digit is one of 10 call districts in the US.
  - Set by your permanent mailing address when applying for a license



# **The Technician Exam**

# Examination Topics

- 1: FCC Rules, descriptions, and definitions for the Amateur Radio Service, operator and station license responsibilities (*Pool Questions: 67, 6 on Test*)
- 2: Operating Procedures (*Pool Questions: 38, 3 on Test*)
- 3: Radio wave characteristics: properties of radio waves; propagation modes (*Pool Questions: 35, 3 on Test*)
- 4: Amateur radio practices and station set-up (*Pool Questions: 24, 2 on Test*)
- 5: Electrical principles; math for electronics; electronic principles; Ohm's Law (*Pool Questions: 57, 4 on Test*)

The actual test is 35 questions. A 70% or better score is required to pass. Up to 9 questions can be missed.

The test each person gets is different than the one his neighbor gets. Some of the questions may be the same, but they'll be in a different order. The software that generates the test randomly selects the required number of questions for each section from the available questions in the pool for that topic.



# Examination Topics

- 6: Electrical components; circuit diagrams; component functions (*Pool Questions: 47, 4 on Test*)
- 7: Station equipment: common transmitter and receiver problems; antenna measurements; troubleshooting; basic repair and testing (*Pool Questions: 47, 4 on Test*)
- 8: Modulation modes: amateur satellite operation; operating activities; non-voice and digital communications (*Pool Questions: 48, 4 on Test*)
- 9: Antennas and feed lines (*Pool Questions: 23, 2 on Test*)
- 10: Electrical safety: AC and DC power circuits; antenna installation; RF hazards (*Pool Questions: 37, 3 on Test*)

There is a \$15 dollar fee for the exam, half of which is remitted to the Volunteer Examining Coordinator (in this case, W5YI) and half is used by the sponsoring club to cover incidental expenses.

If you pass your Technician exam, you can immediately take the General exam at no extra cost.

# The Exam Itself

- Before the exam begins there is paperwork to fill out
  - You must have two forms of ID, one of which must have a picture
- Exam is supervised by a minimum of three authorized examiners
- Each exam is independently scored by three authorized examiners
- You'll be notified immediately of your results

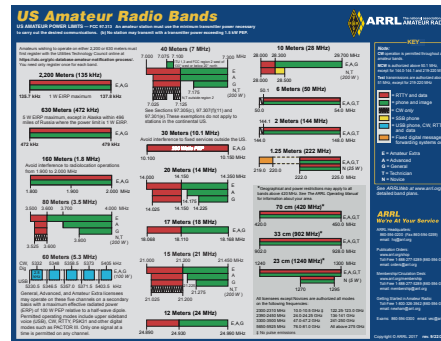


Two pieces of paper, which have to be turned in  
Pencil ... answer sheet is best marked with pencil  
Calculator (not a smart phone!!)

# Frequencies & Band Plans

# Technician Privileges

- CW (morse code) in small segments of the high frequency (HF) bands
- Full privileges in the VHF, UHF, and higher
- Satellites, Space Station, moon bounce, meteor scatter, mesh networks, amateur TV, and much more

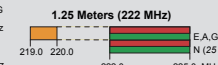
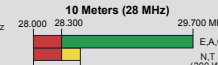
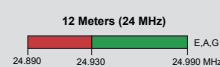
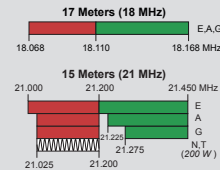
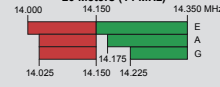
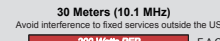
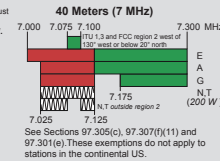
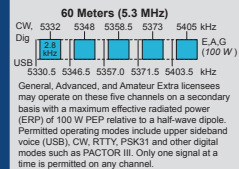
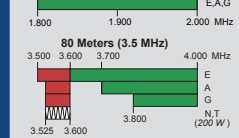
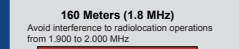
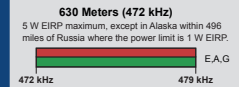


# US Amateur Radio Bands

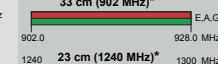
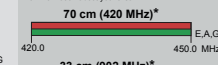
US AMATEUR POWER LIMITS — FCC 97.313 An amateur station must use the minimum transmitter power necessary to carry out the desired communications. (b) No station may transmit with a transmitter power exceeding 1.5 kW PEP.



Amateurs wishing to operate on either 2,200 or 630 meters must first register with the Utilities Technology Council online at <https://utc.org/pic-database-amateur-notification-process/>. You need only register once for each band.



\*Geographical and power restrictions may apply to all bands above 420 MHz. See The ARRL Operating Manual for information about your area.



All licensees except Novices are authorized all modes on the following frequencies:

2300-2310 MHz	10.0-10.5 GHz	122.25-123.0 GHz
2390-2450 MHz	24.0-24.25 GHz	134-141 GHz
3300-3500 MHz	47.0-47.2 GHz	241-250 GHz
6650-5925 MHz	76.0-81.0 GHz	All above 275 GHz

‡ No pulse emissions

**KEY**

Note: CW operation is permitted throughout all amateur bands.

RTTY is authorized above 50.1 MHz, except for 144.0-144.1 and 219-220 MHz. Test transmissions are authorized above 51 MHz, except for 219-220 MHz.

Legend:

- RTTY and data
- phone and image
- CW only
- SSB phone
- USB phone, CW, RTTY, and data
- Fixed digital message forwarding systems only

E = Amateur Extra  
A = Advanced  
G = General  
T = Technician  
N = Novice

See ARRL Web at [www.arrl.org](http://www.arrl.org) for detailed band plans.

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# On the “Air”

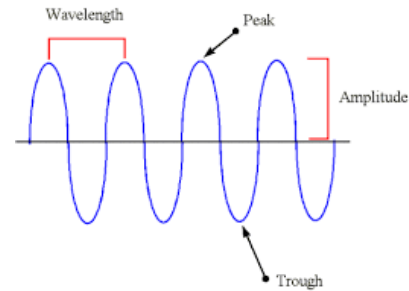
- Communication is made on radio frequencies
- Electromagnetic waves carry the communication
  - It has both an electrical and a magnetic component
- Radio waves travel at the speed of light or about 300,000,000 meters/second



The speed of light is actually 299,792,458 meters per second. That rounds up nicely to 300,000,000.

# Radio Waves

- Measured in cycles per second
- Measurement term is “Hertz” which means, cycles per second
  - The number of cycles per second is the “Frequency”
- Wavelength is measured in “meters”
  - Wavelength and Frequency are inversely related to each other



**Frequency is depicted by the letter 'f' and is measured in thousands of Hertz (kHz), millions of Hertz (MHz), or billions of Hertz (GHz)**

**Wavelength is depicted by the Greek letter Lambda:  $\lambda$  and is measured in meters**

**Wavelength gets shorter as Frequency increases**

$$\lambda(\text{meters}) * f(\text{MHz}) = 300$$

The wavelength of a radio station broadcasting in the AM band at 1010 kilohertz is 297 meters (3 football fields)



# Frequency Spectrum

High Frequency (HF)	3 to 30 MHz 100 to 10 meters
Very High Frequency (VHF)	30 to 300 MHz 10 to 1 meters
Ultra High Frequency (UHF)	300 to 3000 MHz 1 to 0.1 meters
Super High Frequency (SHF)	Above 3000 MHz Shorter than 0.1 meters

6 meter band is where  
146.52 MHz is where  
HF max Technician power is 200 watts  
VHF and up max Technician power is 1,500 watts

# Band Plans

- Band Plans are the dictated ways in which the authorized spectrum may be used as well as the generally accepted segmentation of the authorized spectrum
- In some cases, Amateur Radio is a secondary user of certain frequency ranges
  - The 70cm band is primary for military radar and secondary for amateur radio
  - We must avoid interfering with the primary user
- Stay away from band edges
  - Emissions have width, so transmitting on a band edge means that some of the emission will be outside of the band

## 2 Meters (144-148 MHz)

144.00-144.05	EME (CW)
144.05-144.10	General CW and weak signals
144.10-144.20	EME and weak-signal SSB
144.200	National calling frequency
144.200-144.275	General SSB operation
144.275-144.300	Propagation beacons
144.30-144.50	New OSCAR subband
144.50-144.60	Linear translator inputs
144.60-144.90	FM repeater inputs
144.90-145.10	Weak signal and FM simplex (145.01,03,05,07,09 are widely used for packet)
145.10-145.20	Linear translator outputs
145.20-145.50	FM repeater outputs
145.50-145.80	Miscellaneous and experimental modes
145.80-146.00	OSCAR subband
146.01-146.37	Repeater inputs
146.40-146.58	Simplex
146.52	National Simplex Calling Frequency
146.61-146.97	Repeater outputs
147.00-147.39	Repeater outputs
147.42-147.57	Simplex
147.60-147.99	Repeater inputs

National SSB / CW calling frequency: 144.200 MHz

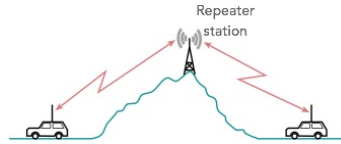
National FM calling frequency: 146.52 MHz

# **Your Radio & Repeaters**

# Radio Characteristics

- A method to switch between transmit and receive: PTT (push to talk)
- A method to store frequently used frequencies and modes (Memory Channels)
- A method to attach an antenna
  - Outside is better
  - Some HT “rubber-duck” antennas are poor performers
- Has at least one mode of operation
  - For VHF/UHF bands, most HT’s offer only FM
- May have a method of setting the frequency (VFO or Variable Frequency Oscillator)
- May have squelch settings to mute the receiver when no signal is present
- Usually offer the ability to operate in Simplex or Split mode

# What is a Repeater?



- A radio that listens on one frequency and simultaneously transmits on another frequency (generally limited to 10 meters and above)
- The “split” between receive and transmit depends on the band (0.6 MHz in the 2 meter band and 5.0 MHz in the 70cm band is common). The split can be either up (+) or down (-)
- To avoid spurious transmissions, repeaters often require a specific sub-audible tone to be sent with the transmission otherwise the repeater ignores the incoming signal ... Specifically called CTCSS (commonly called a PL tone)

CTCSS: Continuous Tone-coded Squelch System

Reverse split means listening on the repeater’s input frequency

Repeaters are often linked, either over the air or over the Internet. The Intermountain Intertie is an excellent example

Local volunteers work to coordinate the frequency pairs used by repeaters in the area to avoid conflicts. The FCC is never involved in this coordination work ... only when transmissions are being interfered with.

Repeaters are required to identify themselves periodically. That can be done either with voice or CW

# Using a Repeater

Frequency	Offset Direction	Offset Amount	CTCSS
147.200	+	0.6 MHz	100.0
449.425	-	5.0 MHz	100.0

- Need to know
  - Frequency
  - Offset (and offset amount if non-standard)
  - CTCSS
- Utah VHF Society ([utahvhfs.org](http://utahvhfs.org)) maintains lists of (most) all repeaters in Utah

**The W4VB repeater transmits on 145.330  
anything it hears on 144.730 Mhz that  
has a sub-audible tone of 131.8 Hz**



**To us this repeater, I set up my HT:  
Set my receive frequency to 145.330 MHz  
Set my offset to "minus 0.6 MHz"  
Set CTCSS on transmit to 131.8 Hz**





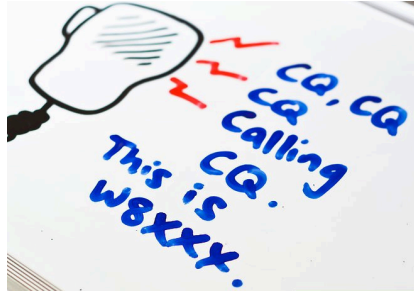
## Utah VHF Society

<http://utahvhfs.org>

**Manages the Intermountain Intertie consisting of a linked repeater system from Billings MT in the north, Boise ID in the west, Flagstaff AZ in the south and Las Vegas NV in the west**

# Ham Radio Terms

- CQ: Calling any station
- QSO: A conversation over the air (also eyeball QSO)
- QTH: My location
- QRT: Going off the air
- 73: Best wishes
- 88: Hugs and kisses
- QRP: Low power
- QRO: High power
- QRM: Man-made interference
- QRN: Natural interference
- QSY: Changing frequency

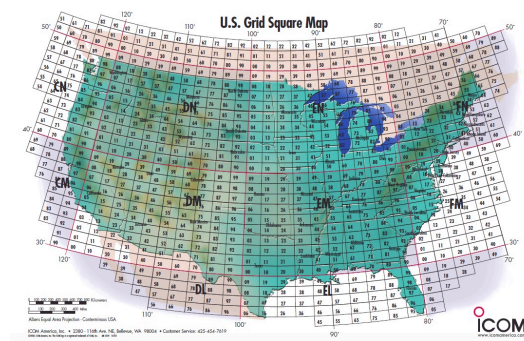


# Getting On the Air

- Listen, listen, listen. Is the frequency clear? Are you on an authorized frequency? While no one has “rights” to a specific frequency, be accommodating
- When giving call signs, transmit the other station’s call sign first then your call sign
- If the other station reports a weak signal, move a few feet
- Mobile stations sometimes have issues with picket fencing
- Weekends often feature contests where stations try to contact as many other stations as possible over a specific time period

# Grid Squares

- A letter / number designator for a specific area.
- Can go up to 10 characters. Most common is 2 letters followed by 2 digits. We're in DN30.
- Last year the ARRL sponsored an International Grid Square Chase.



# Emergency Operations

# ARES and RACES



## Amateur Radio Emergency Service

- ARRL Sponsored volunteer service
- Local clubs can register as ARES clubs
- Usually associated with a local governmental or non-governmental agency
- Practices through weekly nets and community service events

## Radio Amateur Civil Emergency Service

- Sponsored by a civil defense organization
- Usually requires certification by the sponsoring organization
- Responds only when activated
- Practices through regular nets

# Emergency Operations

- FCC Rules ALWAYS apply, even during an emergency
  - However, a licensed amateur radio operator may use any mode or frequency in situations involving the immediate safety of human life or the protection of property
- To signal an emergency situation, transmit your callsign followed by the words “Priority Traffic” or “Emergency”.

# **Nets and Net Operations**



# What Is a Net?

- Most commonly three types of nets:
  - Traffic Net
  - Casual “birds of a feather” net
  - Emergency practice net
- Conducted on the air
  - Usually at a specific time
  - And on a specific repeater or frequency
- Managed by a Net Control Operator (NCS)
  - Stations check in and then only transmit when invited by the NCS



# Message Handling

- Traffic nets relay formal messages from an originator to a destination, kind of like a telegram
  - Local nets collect new messages, deliver received messages
  - Regional nets relay messages to and from other regions and local nets
- The preamble (header) of the radiogram is used to track the message from initiation to reception.
- Note that these messages are third-party traffic

[illegible]

**A key characteristic of traffic handling is passing the message exactly and precisely**

# Local WDARC Net

- Held each Thursday evening at 9:00pm on the Tooele County Linked Repeater System
  - The Wendover repeater transmits on 147.200 MHz, positive offset, with a 100.0 Hz CTCSS tone
- Format of the net:
  - A preamble
  - Club officer checkins
  - Club member checkins
  - Any other checkins
  - Traffic handling
  - Postamble



