
Analog RF Electronics Education at SDSMT: A Hands-On Method for Teaching Electrical Engineers



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Wireless Communication Course

We developed a wireless communication electronics course in the Electrical and Computer Engineering (ECE) department at SDSMT. This course provides a theoretical and **hands-on** education for students.

There is a **large industrial demand** for radio frequency and microwave engineers. We aim to provide SDSMT ECE students with those skills through coursework and through their participation in research projects.

There are many applications of the RF and microwave engineering:

- Radio
- RADAR
- Navigation (GPS, for example)
- Wireless communications
 - » Cellular telephones
 - » Wireless computer networks (WiFi)



Course Text

Our new course is based on an excellent text written by Prof. David Rutledge of the California Institute of Technology (CalTech).

During the semester, the students **slowly build** and **thoroughly analyze** the NorCal 40A radio, which is a low power transceiver (i.e., a combination transmitter and receiver).

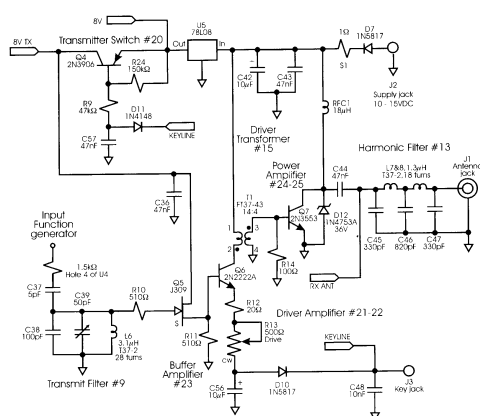
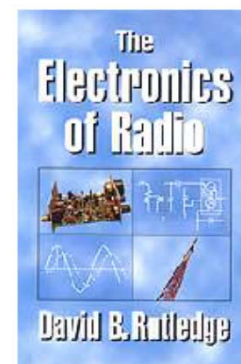


Figure 10.17. The transmitter amplifier chain.

This course is **nontraditional** in the sense that all “homework” is assigned in the form of laboratory problems.

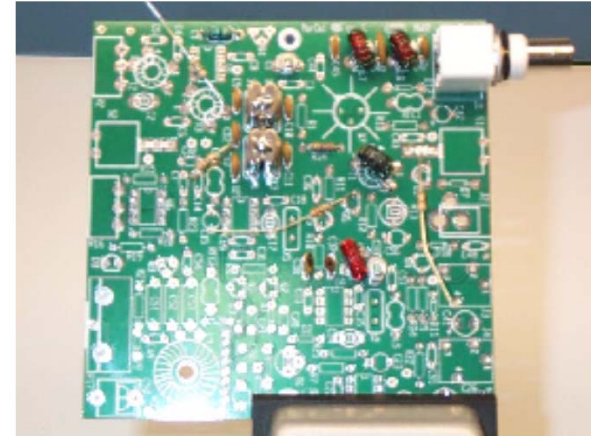
Our course at SDSMT is the **second adoption** outside of CalTech. (I helped develop the first at the University of Kentucky.)

Transceiver Construction

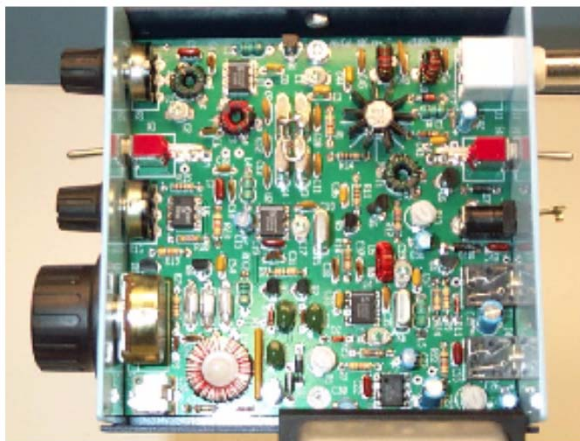
Begin with parts kit:



After two weeks:



After ten weeks (completed):



After six weeks:



Course Equipment

Arbitrary waveform generator

Digital oscilloscope



Multimeter

12 volt
power supply

Soldering Station (we do a lot
of soldering and desoldering!)

Also used:

- frequency counter
- adjustable attenuator
- power combiner
- dipole antenna

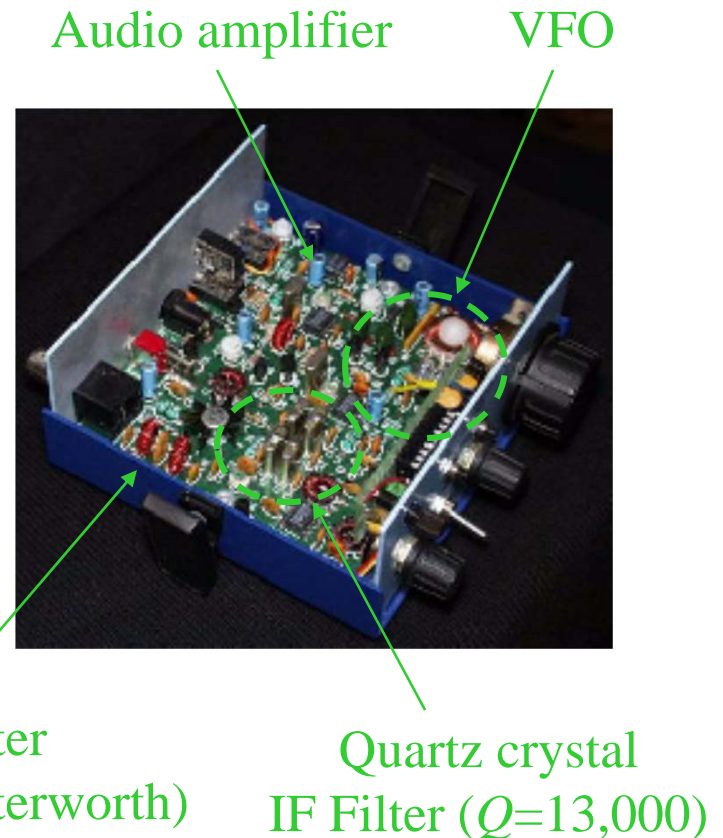
Course Overview – I

In addition to lecture material, the students work through a carefully selected set of 39 lab problems designed to:

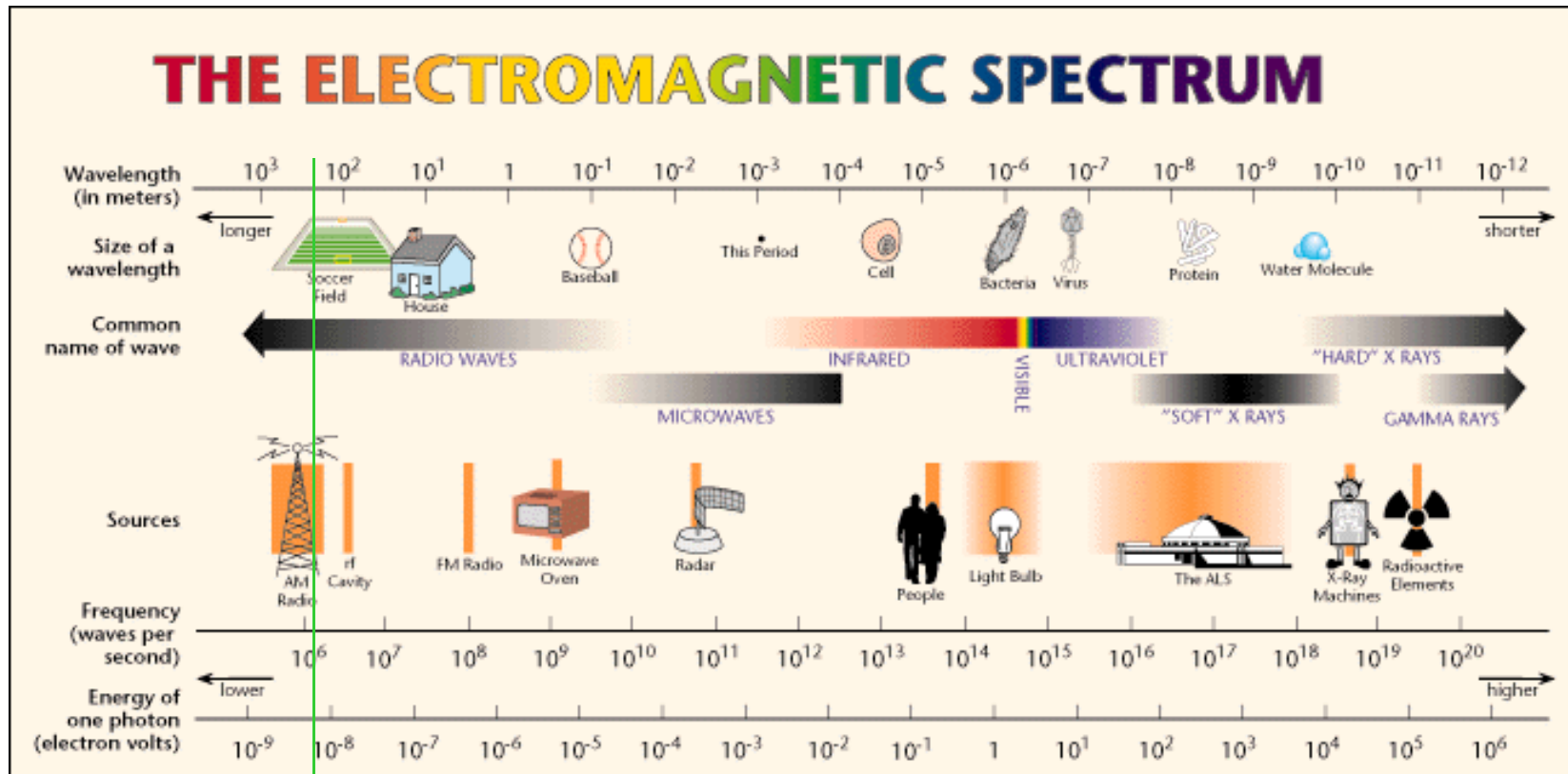
- 1) allow them to **build a working transceiver**, and
- 2) theoretically “**dissect**” its operation.

The photo shows the transceiver the students build from a kit:

- Superheterodyne receiver
- Operates at 7 MHz (40-m band)
- Morse code (CW)
- 2-W output power (QRP)



Electromagnetic (EM) Spectrum



The NorCal 40A transmits and receives EM signals near this frequency.

Course Overview – II

The unique aspects of the course include:

- ◆ Combining theory with extensive hands-on experience.
- ◆ Theoretical and practical experience with a **wide range of circuit components**:
 - ✓ varactors
 - ✓ two other types of diodes
 - ✓ mixer/oscillator ICs
 - ✓ RF chokes, inductors, transformers
 - ✓ five types of capacitors
 - ✓ quartz crystals
 - ✓ transistors (BJT, FET)
- ◆ **A wide range of topics** important to analog electronics are covered, including:
 - ✓ superheterodyne receivers
 - ✓ ladder filters
 - ✓ mixers
 - ✓ transistor amplifiers
 - ✓ power amplifiers (classes A,B,C)
 - ✓ oscillators
 - ✓ quartz crystal filters
 - ✓ transmission lines, antennas
 - ✓ audio circuits

Morse Code

The transceiver students build in this course sends and receives **Morse code**.

Rather than talking into a microphone or listening to voices, a series of dits and dahs are sent in a special code to transmit the individual letters of words. Some call Morse code a method of *digital* communication!

International Morse Code

A	● —	N	— ●
B	— ● ● ●	O	— — —
C	— ● — ●	P	● — — ●
D	— ● ●	Q	— — ● —
E	●	R	● — ●
F	● ● — ●	S	● ● ●
G	— — ●	T	—
H	● ● ● ●	U	● ● —
I	● ●	V	● ● ● —
J	● — — —	W	● — —
K	— ● —	X	— ● ● —
L	● — ● ●	Y	— ● — —
M	— —	Z	— — ● ●



Contact Information

If you would like to know more about this course, or other related topics, please get in touch with me. I would be happy to converse with you by email or telephone. My contact information is:

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