First-Year Amateur Radio Licensing for Electrical Engineering Students

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Marcel is an Electrical Engineering alumnus of California Polytechnic State University in San Luis Obispo. He was a former President and is current Industrial Advisor to the Cal Poly Amateur Radio Club (www.W6BHZ.org). He is very involved in community events and regularly provides communications for bike rides and triathlons, helps at local repeater work days, and assists several testing sessions each year. His Masters Thesis is titled: Radio Direction Finding Network Receiver Design for Low-cost Public Service Applications. Marcel was licensed on Cinco de Mayo in 2008 as KI6QDJ. He received his Extra License in the Summer of 2010 and is now holds the callsign: AI6MS. He is an ARRL Life Member and has used his VE credentials to help license over 673 hams since 2009. Marcel has taught numerous classes including: Introduction to Electrical Engineering for Non-Majors and an Advanced Digital Communications Lab. Marcel currently works as an Electrical Engineering Systems Lead at Amazon Lab126 in Sunnyvale, CA and serves on the Cal Poly Electrical Engineering Industry Advisory Board.

Stanton Chueng Wu, California Polytechnic State University, San Luis Obispo

Stanton Wu is an electrical engineering student at Cal Poly - San Luis Obispo. After getting his amateur radio license in October 2012, he has been an active member in his university’s ham radio club and is currently serving as the club’s president. Stanton volunteers with his club at local bike rides and triathlons to keep communications strong on the course where cell service is not readily available. Setting up the communications infrastructure for events like the Wildflower Triathlons has helped Stanton apply the skills he learns in lectures. He received increased exposure and furthered his skills when he was accepted as an intern at Space Systems Loral to act as a payload systems engineer tasked with designing satellites. He hopes to reach new heights alongside the amateur radio club as they follow Cal Poly’s motto of "learning by doing".

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Abstract

In this paper, we describe the results of having all Electrical Engineering students take their amateur radio technician examination during their first quarter on campus as part of an orientation course. Benefits include students becoming licensed to use Federal Communication Commission (FCC) allocated amateur radio spectrum, introduction of circuit/electronics concepts and applications early in the curriculum along with an increased electronics experimentation culture among students. The large pool of licensed radio amateurs provides a sustaining source of membership for the on-campus amateur club and radio community.

Introduction

The amateur radio service was created to allow for public use and experimentation of one of our key natural resources, the electromagnetic spectrum. In order to use this public resource, individuals must pass an FCC examination that is taken from a pool of 426 publically available technical questions. The first year Electrical Engineering orientation course has made the technician-class amateur radio examination a required part of the curriculum since 2011. Students are asked to study the FCC examination question pool outside of the classroom environment as part of their homework assignments. The on-campus W6BHZ radio club then administers the FCC sanctioned examination during a single 50-minute class period. Students have shown an average pass rate of 85% for the examination over the last 5 years. Students who do not pass the examination in class are allowed to re-take the FCC examination for full credit at other examination sites by the end of the course period. Over the last 5 years, over 700 Electrical Engineering students have successfully passed their amateur radio examination as part of the 1st year orientation class. Projects created by the amateur radio community were incorporated into the formal and informal curriculum for the Electrical Engineering department to take advantage of the newly FCC licensed students. Informal assessment of 1st year amateur radio licensing includes increased interest in the RF/microwave/communication concentration of the curriculum, strong membership growth in the amateur radio club on campus, and a devoted group of licensed Alumni who come back to campus each year to participate in communication-related service events for the community and electrical engineering department.

Licensing Examination

Amateur Radio Licensing is administered by the Federal Communications Commission (FCC) in the United States. There are three levels of licensing: the Technician, General and Extra Class levels. The 1st year licensing activity focuses on the technician-level examination. The FCC authorizes 14 different Volunteer Examiner Coordinator (VEC) Organizations to administer these examinations across the U.S. These VEC organizations are listed on the FCC web site.
After reviewing the VEC organizations in recent years, the Laurel VEC organization was selected because they offer nationwide coverage and do not charge any fees for taking the FCC examination. The no-fee solution simplifies using the FCC technician radio examination as a learning tool in the Electrical Engineering Curriculum and increases accessibility of the license for first-year students.

In considering the use of the technician examination as a University teaching tool, it is useful to review the contents of this examination\(^2\). The subject areas of the FCC technician examination are as follows;

**Subelement T1 – FCC Rules, Descriptions and definitions for the Amateur Radio Service, Operator and station license responsibilities;** This section outlines the FCC rules and regulations governing the amateur radio bands. It also exposes students to the FCC frequency allocations, primary and secondary licensees, the ITU (International Telecommunications Union), and mode-specific guidelines for maintaining in-band signaling.

**Subelement T2 - Operating Procedure;** In this section students must learn about which frequencies are available for use by radio amateurs. It also outlines the different types of emission formats can be used in different bands such as Single Sideband and FM modulation. The section also outlines FCC rules on station identification and traditional operational practices so that stations can live harmoniously on shared spectrum.

**Subelement T3 – Radio wave characteristics: Properties of radio waves; Propagation modes;** This section has practical questions to help students understand the characteristics of the radio spectrum. Questions include finding the length of a half-wave dipole antenna for a particular frequency band. The material also helps examinees understand why 3-30 MHz signals might interact with the ionosphere but VHF and UHF signals are most often confined to short range communications and interaction with repeaters systems.

**Subelement T4 - Amateur radio practices and station set up;** This section talks about practical issues associated with assembling an amateur radio station.

**Subelement T5 – Electrical principles: math for electronics; Electronic principles; Ohm’s Law;** This section covers the topics of Ohms law, DC/AC circuits and introductory electronics.

**Subelement T6 – Electrical components: semiconductors; Circuit diagrams; Component functions;** This section of the examination asks students to identify elements found in circuit diagrams. It also provides material about functionality found in example schematic diagrams.

**Subelement T7 – Station equipment: Common transmitter and receiver problems; Antenna measurements; Troubleshooting; Basic repair and testing.** This section covers test equipment theory, taking measurements, and troubleshooting of commonly used equipment.
Subelement T8 – Modulation modes: Amateur satellite operation; Operating activities; Non-voice and digital communication; These questions address Amplitude Modulation, Frequency Modulation, Single Sideband and digital modes of communication. This section also outlines the role of amateur radio in providing public-service communication activities for events such as bicycle races. It also addresses how the amateur radio service is part of the emergency communication network in the event of natural disasters.

Subelement T9 – Antennas and feed lines; Antennas and transmission lines are a key part of setting up radio transmitters and receivers. Questions on the exam talk about dipole antenna length calculations and the purpose of feed lines.

Subelement T0 – Electrical safety: AC and DC power circuits; Antenna installation; RF hazards; This section of the test addresses why safety precautions are necessary when working with high-voltage and high-current equipment. It also addresses the safety concerns with high voltage AC circuits and absorption of Electromagnetic Radiation by the body.

Examination, Preparation, and Results

In the first year licensing strategy for Electrical Engineering students, there are four offered methods to complete student licensing goals. The goal of offering these four methods is to make sure that everyone is successful in obtaining their FCC license.

Method 1: Students are emailed about getting their FCC amateur radio technician license in the summer in advance of classes starting on campus. It is suggested that they might want to go to a locally-sponsored licensing event in their home community before arriving on campus if they have interest.

Method 2: The W6BHZ amateur radio club offers a “Get Your License in a Day” workshop. This examination is scheduled on a Saturday and runs from 9AM to 4PM early in the first quarter after students arrive on campus. The morning and early afternoon sessions consist of instructors going over all of the material for topics 0 through 9. After each instructor session, students are asked to read the corresponding questions and correct answers for that section. Emphasis is on exposure to the materials and recognizing the correct answers for the 426 question test pool. The examination is given after the end of the study periods. Average pass rates for this method has been around 90%. This method is often viewed in a negative light as many other “ham cram” events only study the questions and answers. However, the W6BHZ radio club modified the standard ham cram format by adding dedicated short seminars proceeding each study session to provide context, applications, and basic framework to better understand and comprehend the material. This modified instruction method is very well received by the attendees and has shown great success rates year after year. The great advantage of this
method is that no other studying or time commitment is required for students choosing this method.

Method 3: The students take the amateur radio examination as a midterm in their freshman Electrical Engineering orientation lecture class. Students are asked to register in advance by filling out the FCC license application form. Students are referred to on-line study courses that are available through multiple web sites in order to prepare for the examination. Some of the on-line materials emphasize memorization of the material. Other on-line sites take a more comprehensive approach where much more background material is given to support each question. Most sites provide practice examinations. Students work on the material until they get proficient in passing the practice examinations. The actual FCC-authorized 35 multiple-choice question examination is taken during the 50 minute class period. Most of the students finish in the first thirty minutes with everyone finishing within the full hour. Special arrangements are made for those who may need more time. Students must score at least 74% to receive their license per the official rules. Average pass rate for this method has been on average 85% out of a total of 832 students taking the test. This in-class exam method is very effective for student attendance since it occurs during the normal class hours in the same room. It does provide for significant challenges for the administrators of the exam due to the extensive exam regulations required to run the session. For example, per regulations, each student’s identification needs to be verified by 3 of the VE’s (Volunteer Examiners) and all examinees must stay under the supervision of 3 VE’s at all times. The resulting session requires at least 6 VE’s to run completely. Fig 1 shows VEs in action. Volunteer Examiners must have at least a General Class license and complete the basic test and application to the authorized VEC (Volunteer Examiner Coordinator). The VE team must work with the VEC to allow use of scantrons forms for the exam. Scantrons can be machine graded under the supervision of the VE’s and allows for much quicker and more accurate grading of all the exams from these sessions. Historically, each exam needed to be hand-graded by a VE and then checked by 2 more VE’s. This was extremely labor intensive and very impractical for sessions that exceeded 100 students at a time.

Method 4: Students who do not pass using methods 1, 2 or 3 can pass the test later in the quarter at a community-offered amateur radio examination.

The students get very quick reporting on the results of their FCC examination, usually on the same day as the test is administered. Their official FCC amateur radio call signs are typically issued the next business day after the examination date. The students tend to be excited when they receive their FCC-issued radio call sign.
Follow-Up After The FCC Examination

The W6BHZ amateur radio club on campus offers several activities to encourage utilization of the newly issued licenses. A special radio projects day is offered in the following quarter. The club runs a Radio Loaner Program in which VHF/UHF radios are available for rent and rent-to-own for all interested students. This inexpensive option is great for students to try out a proper amateur radio without requiring an expensive up-front investment. Typical loaner radio rates are $20 per quarter and all fees go directly to the cost of the radio if the student chooses to keep it. This means that any student that stays with the loaner radio program for approximately 2 years then owns their own Yaesu FT-60R radio. The club maintains the local W6BHZ VHF/UHF repeater system on campus, which allows the group to meet other interested amateur radio operators from around campus and the surrounding community. Another rewarding activity for students is the annual transmitter hunt that is held on campus. For this event, a direction-finding antenna system is built by the students in the morning and then used that afternoon for a “T-Hunt” or transmitter hunt. In this T-Hunt, students use their hand-made Yagi-Uda directional-antennas to search for hidden transmitters on campus. This exposes students to antenna construction, radio direction finding, and propagation and is always well received. The most effective engagement tool for students has been providing communication services for athletic events in the community and local area. The W6BHZ radio club has been partnering with the San Luis Obispo Bicycle Club (SLOBC) since 2008 to provide radio communications and logistics support for their twice-annual bicycle ride events. These fundraising community events are a great way for students to get on-the-air experience on the radio and see first-hand how their equipment and skills can help run a smooth event and, in some cases, save lives. These great events get the students involved in the local community and all the proceeds help various local non-profit organizations. The pleasant side-effect involvement in these events is exposure and improved relationships between the local community and the student body.
Value Proposition for Students Getting Their Amateur Radio License in Their First Quarter (or Semester) On Campus

In end-of-the-quarter student feedback of the course, students provide a mixed review on the value of the FCC examination as part of the Freshman Electrical Engineering orientation class. A large majority of the class felt (80%) that they probably would not directly use the FCC-issued license in the future. For a smaller group (approximately 5%), the experience was transformative in that they found a new passion in the radio science part of Electrical Engineering early in their higher-education. The remaining 15% felt that they might use the FCC-issued license but they were not sure. 50% of the students reported that they valued exposure to a large number of topics in Electrical Engineering as part of the radio examination. Many students felt that some of the examination topics were beyond their understanding in their first quarter of Electrical Engineering education; but still valued being exposure to these topics.

Employers and members of the Electrical Engineering Advisory board members stated that it is novel and useful to have students listing their amateur radio licenses as an asset in their early education and a useful item to list on their resumes. Students who did not actively use their FCC license often did not list their call sign on their resume. Students who did list their FCC call sign on their resume also often listed some of their projects associated with amateur radio.

This 1st year licensing event was essentially driven by the passion that the authors have found for amateur radio in forming their interest and passion in Electrical Engineering. Many Electrical Engineering faculty members are ambivalent about the 1st year amateur radio licensing initiative but generally support the fact that it can encourage students to be electronics experimenters early in their Electrical Engineering program. The faculty members who have their radio license are the most supportive of the initiative.

Summary

This paper presents a summary of a 5-year initiative to have 1st quarter (or semester) Electrical Engineering students take the FCC amateur radio technician license examination as a required part of their orientation class. This program was successful in building a sustainable amateur radio community on campus and providing a venue for hands-on experience in radio communications. For a small fraction of the students who take the examination, it became a transformative event in their Electrical Engineering student experience. For the majority of students, it was educational and viewed as a positive experience in their early Electrical Engineering curriculum.
References:

[1]. The authorized Volunteer Examination Coordinator Organizations are found at http://wireless.fcc.gov/services/index.htm?job=licensing_5&id=amateur