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IEEE Antennas and Propagation Society Scholarship and Fellowship recipients

The IEEE Antennas and Propagation Society Education Committee is proud to announce this year's second-semester scholarship and fellowship recipients.

Undergraduate Scholarship Recipients (receiving $1000 each)

Aytac Alparslan

Koc University, Faculty Mentor: Prof. M. Irsadi Aksun

Afshin Edrissi

University of Utah, Faculty Mentor: Dr. Cynthia Furse

Chia-Wei Liu

Yuan-Ze University, Faculty Mentor: Prof. Hsi-Tseng Chou

Graduate Fellowship Recipients (receiving $2500 each)

David Landon

University of Utah, Faculty Mentor: Dr. Cynthia Furse

Jamesina J. Simpson

Northwestern University, Faculty mentor: Prof. Allen Taflove

The next deadline for undergraduate and graduate scholarships is November 1, 2005. More information can be found at: http://www.ece.utah.edu/~cfurse/APS.

International Survey of Electromagnetics Education

The IEEE Antennas and Propagation Society is collecting a survey of electromagnetics education around the globe. This survey is headed by Mako Ando (mando@antenna.ee.titech.ac.jp) and Sembiam Rengarajan (srengarajan@csun.edu). The purposes of this survey are to (1) compare global trends, (2) understand "typical" EM curricula, (3) locate novel EM teaching strategies to share with the community, and (4) assess possible projects for IEEE support that would benefit the EM educational community. If you have not already completed this survey, please take a few minutes (about 10 minutes) to tell us about the EM curriculum at your university. The survey can be found at http://www.ece.utah.edu/~cfurse/APS.

Integration of Signals/Systems and Electromagnetics Courses Through the Design of a Communication System for a Cardiac Pacemaker

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As students go through a traditional ECE program, they learn a great deal about individual components and tools: transistors, op amps, diodes, resistors, transmission lines, and Fourier transforms. In a traditional lab they build and test these individual units. But when the lab is done, whether or not it worked, they can more or less "forget it." And, when the class is finished, they stash their notes and move on to the next subject, often forgetting much of what they have learned. In spite of all of our lecturing, students often do not see the relevance of what they are supposedly learning, do not see how it fits into a system, and do not see how they will ever use it. Their motivation suffers, their grades droop, and the bright, energetic, creative, and optimistic student becomes mired in a morass of disconnected abstraction...before transferring to another major.

Imagine if, instead, from the first day of class, students are challenged to build a simple but complete system, using most of the concepts they will learn in the class. Piece by piece, they learn about the components they need, design and test them, perhaps good-naturedly competing with their fellow students for the best designs. When they ask if their designs are "good enough," they are encouraged to check it out for themselves, and to predict how it will affect their system in the end.

This system-level design concept is part of a new experimental program at the University of Utah, supported by the National Science Foundation, the College of Engineering, and the University of Utah, to integrate multiple concepts and courses through laboratory design projects. One such project is the design of an FSK communication system for a cardiac pacemaker (Figure 1), which combines labs from the junior-level "Signals and Systems" courses and the junior-level electromagnetics course, which are both taught in the same semester.

The following is a brief description of the electromagnetics labs.

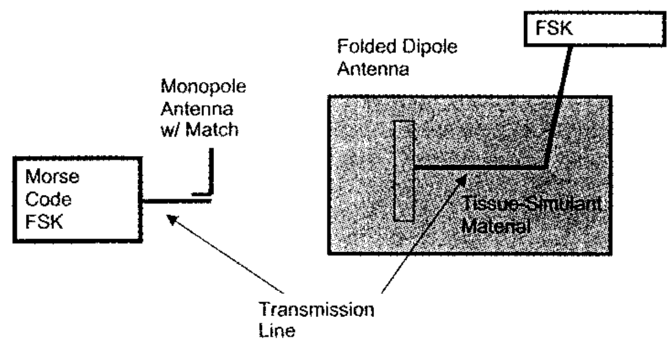

Figure 1. A block diagram of the FSK communication system for medical implants.

EM Lab 1: Dielectric Properties

In this lab, students learn about the dielectric properties of materials, and how these properties affect electric fields (loss, phase shift, velocity of propagation, etc.). They make a mixture of water, sugar, and salt that has the same electrical properties as two-thirds muscle, and use an HP dielectric-measurement probe to measure its properties. This mixture will be used in the last lab for testing the communication system, and the calculations of loss will be used in the link budget in Lab 7.

EM Lab 2: Transmission Lines

In this lab, students learn about different types of transmission lines, including coaxial cable, two-wire lines, and microstrip.

They calculate and measure characteristic impedance, and compute and understand R', L', G', and C' parameters that are used throughout the class for analysis of transmission lines. They use the measurements of loss on transmission lines in the link budget in Lab 7. A network analyzer and capacitance-measurement system are used.

EM Lab 3: Telegrapher's Equation Solution using Finite-Difference Time-Domain (FDTD)

In this lab, students learn how to simulate a transmission line using R', L', G', and C' parameters and Maxwell's Equations in one dimension with the FDTD programmed in *MATLAB*™. They simulate how different dielectrics affect the characteristic impedance, loss, and propagation velocity in the line. In future years, we plan to have them also simulate the different layers of a body model, and how the fields will propagate into the torso.

EM Lab 4: Transient Analysis on Transmission Lines and the Time-Domain Reflectometer (TDR)

This lab provides additional insight into transmission lines. A time-domain reflectometer is used to determine loads, learn about transient voltages, and better understand the concept of impedance.

EM Lab 5: Monopole Antenna Design and Impedance Matching

In this lab, students learn about designing single-stub matching circuits in a steady-state environment. They also learn about antennas, their input impedance, radiation patterns, and how to match the antenna to a source. A monopole antenna with a microstrip feed is tuned to 433 MHz, and matched with a single microstrip (parallel) open-circuited stub. This is made out of copper tape that can be moved around on the board to see the effect of small changes in stub length or location. A network analyzer is used for measurements in this lab.

EM Lab 6: Numerical Integration for Biot-Savart's Law

In this lab, students continue to learn new programming skills to solve the Biot-Savart law, using trapezoidal integration. The magnetic field is computed for the monopole antenna from Lab 5.

EM Lab 7: Link Budget and Radiation Patterns

This lab combines many of the previous labs to develop a link budget for a pacemaker communication system. The link budget (programmed in *Excel*™) predicts how much power is received from a known transmitter. The reflection and gain from the antenna, the loss in the cables, the loss in the tissue simulation material, and "loss" from the Friis transmission equation are included. The radiation pattern of the antenna is measured, and the effects of multipath are also seen. These effects are included in the link budget, as well.

EM Lab 8: FSK Communication System

This lab is a culmination of many of the other labs to test a simple frequency-shift-keyed (FSK) communication system. This system uses filters that can be designed in the signals course, and the concept of frequency-shift keying, which uses a frequency of 420 MHz for a "0 or dot" and a frequency of 460 MHz for a "1 or dash." A message is sent in Morse code from the transmitting monopole antenna from Lab 5 outside the "body" to a folded dipole insulated with silicone inside a vat of the tissue-stimulation material designed in Lab 1. The transmitter is a voltage-controlled oscillator (VCO), the frequency of which is controlled by a push button and analog circuitry. The receiver is made from two bandpass filters and diode detectors. The link budget from Lab 7 is verified by seeing how far the system transmits.

The following is a brief description of the signals and systems labs.

SS Lab 1: Fourier Transform and Signal Analysis

This lab helps students to understand the concepts of the Fourier transform and signal spectrum through a sequence of fun experiments. It begins with a pre-lab assignment that is done by students before going to the laboratory. In this pre-lab, students' memory is refreshed on how to use *MATLAB* as a computational and visualization tool. They also use *MATLAB* to generate a set of musical notes that they can play and hear. By putting a few notes together, students generate a piece of music. They learn that a signal (such as a piece music) is made up of sine waves. They also experiment and find out how the presence of harmonics can result in more pleasant sounds. This pre-lab is graded and returned to students before they begin their work in the laboratory. The graded pre-labs highlight the students' weaknesses, and guide them in doing things in a more correct way.

During the actual lab session, which runs over two weeks (a total of six hours), students develop a simple *MATLAB* program for the Fourier analysis of signals. The signals generated in the pre-lab are analyzed using this program. The students are then given another piece of music, which is unknown to them. They use Fourier analysis to analyze this signal, and record the frequency and duration of each note. With this information, they generate the latter piece of music through their own code, and confirm its accuracy by listening to it.

At this stage, students have not been taught the Fourier transform in this class, but they have some idea of what the Fourier transform means through their mathematics classes. In our experience, we have found this lab experiment very helpful in preparing students for an in-depth understanding of Fourier-transform concepts and their applications, which are taught in the subsequent weeks in the class.

SS Lab 2: Modulation Techniques

This is a five-week-long experiment about frequency and amplitude modulation. Using electronic components, students build a frequency-shift-keyed (FSK) circuit. Both modulator and demodulator modules are constructed and tested. The carrier frequencies used here are 1 kHz and 5 kHz for representation of logical 0 and 1, respectively. We have purposefully chosen these low frequencies to allow straightforward prototyping in the laboratory using breadboards. The concepts from this experiment are expanded in the EM class, where students build the FSK system in the MHz range.

To further experiment with other types of modulation, the FM signal generated in the first part of this experiment is amplitude modulated (AM) by a 100 kHz carrier. The corresponding AM demodulator is also constructed, and the complete system – consisting of an FM circuit, an AM modulator, an AM demodulator, and an FM detector – is tested at the end of the experiment.

SS Lab 3: Interpolation

In the later part of this class, students are exposed to the concept of sampling, Nyquist rate, and the reconstruction of signals from their samples. In this experiment, students learn how digital-filtering techniques can be used for signal reconstruction. They use *MATLAB* to design filters for this purpose. This lab is executed over a period of two weeks (a total of six hours).

Additional Information

Integrated System-Level Design Project:
http://www.ece.utah.edu/~cfurse/NSF

Introduction to Electromagnetics:
http://www.ece.utah.edu/~ece3300. Contact the authors for the instructor information for this lab.

Fundamentals of Signals and Systems:
http://www.ece.utah.edu/~ee3500/