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Your Help Needed for Survey of EM Education

Please let me remind you, if you have not already, to help us complete the survey of EM education at www.ece.utah.edu/~cfurse/APS. This should only take you about 10 minutes, and we very much need *your* help.

$1000 Undergraduate and $2500 Graduate Scholarships

The next deadline is November 1, 2005. See www.ece.utah.edu/~cfurse/APS for more details.

13 Crazy, Notorious Things to Do in an EM Class

The average attention span of an adult human is 12-20 minutes. Our lectures are 50-80 minutes. Attention Span Math reminds us to take a break now and then, and to bring the class back to life by bringing some life to the class. Many students learn things better if they can see and touch them, so this column is dedicated to them. Here are 13 physical, kinetic, visual (and fun) things to do to make your EM class notorious (and to wake up even the students in the back row).

Do the Wave

When teaching basic wave motion and reflection, try "the wave" in class. As you run (yes, run! – it works better that way) from the front of the classroom to the back, have the students stand up and wave their arms in the air, then sit back down, hopefully while being able to turn around and see the wave propagating behind them. You should be able to see a plane wave of students propagate from the front to the back of the room. To see the reflected wave, just turn around and run back.

Do *The Propagation*

(With credit to Dave Kelly, Bucknell.) Bring in a tape of *Locomotion* [a popular "oldie" song describing how to do a dance] and play it at high volume. Then, demonstrate vector wave behavior with one arm pointing above your head (the **E** vector, of course) and the other to your side (yep, it's **H**), and swing them around in proper linear, circular, and elliptical wave behavior. A high dB level of the music is sure to help. Get the class on their feet, and do it together. (At least, no one will be asleep by the end of *this* lecture!)

Bring "Toys" to Class

There are a lot of "hand-me-arounds" that can help to explain EM concepts. I am the very lucky recipient of a large radio-station coaxial line, with melted holes from a misguided standing wave; antennas of all sorts; several generations of half-disassembled cell phones; polarizing filters; holograms; waveguide components; filters; and more, large and small. Let your students know you like "toys," and your collection will grow.

Dress up Like a Mad Scientist

Just a pair of glasses and a lab coat will do it. Re-enact the discovery of Faraday's Law in class.

Have a Mock Trial

Assign your class to read in advance one of Jim Lin's columns on EM radiation and health in the IEEE AP-S *Magazine*. Also, assign each student to read one of the supporting articles he references (be sure students can easily access them via library reserve, online, etc.). Distribute the reference material reading so that at least two to three students read each of the reference materials. They will be the "expert witnesses" in the trial. Come into class with a written rolled up "summons" to appear in court for causing brain cancer/ headaches/whatever the article discusses. Make the accusations sound dire and expensive, and as official as possible. Hand the summons to an unsuspecting student, and have him or her read it to the class. Have the student "hire" half a dozen engineering colleagues and a lawyer to help prepare their defense. Bring your black graduation robe (sorry, ivy-league profs, this only works with black robes), and make one of your students the judge. A gavel is also helpful here, as this is a noisy assignment! The class will act as the jury. Have the judge choose a team of prosecutors, which has three minutes to prepare their case. Start the trial by having the prosecutors explain the reasons for the accusations (you will find the factual reasons in Lin's column, but, of course, the prosecutors are not limited to those). They should call expert witnesses who have read the references that support their case to testify. The class should keep a "score" sheet of the pros and cons brought out during the trial, and the rebuttals to the arguments. When the prosecution has completed their case, the defense takes the stand. They also call "expert witnesses," who explain their side of the story. Again, the class takes notes. By now, much of the class has been involved on the stand, and they are likely to be getting uninhibited (i.e., noisy) in their commentary on each others' performances. Allow each side two minutes for rebuttal and summary, and then ask the class (jury) to vote on which side wins. Have the judge count up the votes (a show of hands is OK if you don't have time for ballots), and award a golden goose (or some other silly award) to the winning side.

Give out a "Maxwell Award" to the Top Student(s) in Class

(Thanks to Bob Nevels for this one.) Have a T-shirt printed in your school colors (perhaps with your school logo, too) that says "In the beginning, God said [put Maxwell's equations here], and there was light." Have several printed (T-shirts are quite inexpensive in bulk), and use them each year for the annual (or semi-annual) Maxwell award to be given to the student(s) with the high score on the last meeting day of class. Take a picture of the winner(s), and keep it posted in a conspicuous place. This created great notoriety and some healthy competition that motivated the top students to press to do just a little better, especially after the award had been given out a few years.

Bring a Ball or Globe to Class

...to explain spherical coordinates (thanks to Dave Kelly). A white-board marker works great on the inexpensive children's bouncy balls that are about a foot in diameter. A bit of duct tape at the top makes a good handle or hangar (and you will need it). If you have a small enough class, pass them out for the students to work out the angles, vectors, etc. An oatmeal canister covered with paper makes a good demonstration for cylindrical coordinates.

When Teaching FDTD, Make a Cardboard Yee Cell

Have each student bring a square cardboard box (or print them on cardstock, and cut/tape them together in class), and draw their own Yee Cell, to be used throughout the semester.

Sing a Few Good Songs

To explain frequency-hopped spread spectrum, divide the class into three parts, and have each part sing a different song (*Row Your Boat, Mary Had a Little Lamb, Twinkle-Twinkle Little Star*). Have the students listen for their own song, which they will easily hear regardless of the extraneous noise.

Do a Skit

To demonstrate how a cell-phone network functions, create a skit where the cell phones talk to the base stations and the mobile switching office, etc: see http://www.ece.utah.edu/~ece5960 (click on Lecture Notes, and see Lecture 1).

Build an Electromagnet

...to demonstrate the current/**B**-field relationship. Wrap a wire several (20-30) turns around a 16D box nail ("bright" nails work better than galvanized). Hold the ends of the wire on either side of a D-cell battery. (Be a little careful: you are short circuiting the battery, and you don't want it to get too hot.) You can pick up several paper clips with either end of the nail. More turns of the wire will mean more paper clips. When the current is removed, the nail is now permanently magnetized (especially if you use this nail year after year). To demagnetize it, throw it hard on the floor (preferably tile, rather than carpet). Go in to class a few minutes early with enough batteries, nails, wire, and paper clips to share.

Take an Antenna Tour

(Thanks to Om Gandhi, University of Utah, for this one.) When teaching about antennas, arrange for small groups of students to visit local antenna sites (radio and TV stations, etc.), where they can take photos and give a presentation for the rest of the class.

EM Simulations/Movies

The use of movies, simulations, and visualizations is great help in understanding fields and waves. Several of these are available at www.ece.utah.edu/~cfurse/APS.