EE 252 **Spring 2004-05**
Len Tyler

ANTENNAS FOR TELECOMMUNICATIONS AND REMOTE SENSING

GENERAL INFORMATION

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Lectures:	MWF: 9:00 AM, Skilling 191 Wednesday, March 30, through Wednesday, June 1 2005
Midterm Exam:	Week of May 2 (day TBA), covering material through April 22.
Project Due:	June 3 at 12:00 noon
Prerequisite:	EE 142 or equivalent

This course consists mainly of lecture material supplemented by readings from the required text, Stutzman & Thiele, *Antenna Theory and Design*, Second Edition, 1998, and other references. Lecture notes will be handed out as applicable. Special handouts will be distributed from time to time. Reading assignments will be given for most class meetings. Problem assignments will generally be given on Fridays and collected on Fridays, with the results handed back by the following Wednesday or Friday; problem sets will be accepted on the Monday following the Friday on which they were due… with a two point penalty. Discussion of homework is encouraged to promote understanding, but the work submitted should be your own. There will be a *midterm exam*, and a *term project* (note dates above). Final grades will be based on the written work weighted 40% for the term project, 25% for the midterm, and 35% on homework.

A course syllabus and a short list of reference books are attached. Assigned readings will be from this list or from handouts. You may also find that a particular book presents material in ways you can more easily understand—so look around for a book you find comfortable. Stutzman & Thiele is required. There are copies under EE 252 at the bookstore. Other recommended books are: (a) Kraus, *Antennas*, 2nd Ed, 1988, and the more recent Kraus and Marhafka, Antennas, 3rd Ed., 2002 (Kraus is *very strongly recommended* for its intuitive presentation and breadth); (b) Balanis, *Antenna Theory: Analysis and Design* is a modern treatment which is somewhat more expansive than the text; (c) Johnson & Jasik, *Antenna Engineering Handbook* provides an extensive overview of many, many antenna types, but is short on explanation, it is a good starting point in understanding of practical approaches; (d) Elliott, *Antenna Theory and Design* is an excellent text, but the level of analysis is higher than what we will use in this course. These works give different cuts through the same material. Kraus is more introductory than our text, while Balanis is more advanced than the text, and Elliott is the most advanced work in this list.

Antennas are found in many locations around you, and their number is growing very rapidly. Manmade electromagnetic waves radiated from a large variety and types of antennas for purposes of broadcast or point-to-point communication rely on antennas for their launch and reception. These waves exist everywhere, and a near continuum of such waves is present filling this room at this moment! Similarly, all bodies above a temperature of absolute zero emit natural electromagnetic waves, which also surround you. Antenna systems can be used to receive natural radiation as well as manmade. While often taken for granted, antennas are critical to modern radio communication systems, and with the second 'wireless' revolution now well along, are becoming more broadly important for the future. Antennas-plus-signal processing represent a probable 'future' of 'dense' wireless communications systems. Similarly, in another role, antennas-plus-signal processing form a primary experimental technique for sensing our environment. As examples, radar systems probe the manmade and natural world and monitor human activity by use of active sounding or echo location techniques; other, passive remote sensing systems rely on natural radio emissions as their signal source. Both are critically dependent on antenna systems for the electromagnetic interface between the electronics of the sensors and waves in space.

In this course we explore the mechanisms and structures of antennas and antenna systems by drawing connections among Maxwell's equations, radiation, circuit theory, and the lore of antenna technology. In particular we will try to make sense of the dual nature of antennas in which they must function and be interpreted *both* as a circuit element and as and electromagnetic structure. Some analytic tools, some computational skills, and some imagination will be required.

In order to obtain a better awareness of antenna systems and how they are employed, each class begins with a short 'show and tell,' in which you are expected to report characteristics of antennas and antenna systems that you see as you go about the campus and the wider area. Please sketch, photograph,[1] or otherwise capture the approximate dimensions, location and siting particulars, size, orientation, structural characteristics, etc. of antennas you notice and you either wonder about or wish to describe. Hand in your notes to the instructor at the beginning of class, who will in turn attempt to interpret your sighting. (An alternative to the rubric for this period of the class is "Stump the instructor!") The Bay Area and the foothills behind campus abound with various antenna structures. Montebello Ridge, Mount Diablo, and many other elevated sites including tops of buildings (*e.g.,* Durand) carry significant numbers of antennas. Collectively, we will try to understand the antenna system you report and deduce how it works. *Any* antenna is fair game unless previously reported. Don't be shy, and don't think that you see only 'simple antennas' that your colleagues already understand.

Occasionally, you will need to do some computations—this is a great way to explore a variety of effects in cases where analytic approaches may be too difficult (impossible sometimes!) or too time consuming. As a standard practice please use MATLAB for all problem assignments requiring numerical work. If you do not have a research or work computer, a PC, or a Macintosh running this software, it is available through the EE Department for your use on campus. Please check into the campus facilities and get set-up with an account, if needed.

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[1] Get up close! Photos from moving cars and from significant distances are not very effective—the antenna needs to fill the viewfinder frame of your camera in order for you to capture important features; details may require that you get even closer or try a long focal length lens, if available. Do not climb fences or otherwise approach high-power transmitters, however!