You will be creating a numerical model and a video that is between 3 and 5 minutes as your final project. If you are registered for 6340, you may work individually on your final project. If you are registered for 5340, you may work either individually or in teams of two. (Note: If you decide to work as a team, it must be clear that both of you contributed substantially to both the modeling and the video production.) Your video should provide both an overview of your topic and information about your modeling methodology and results. You may include interviews of yourself and/or other people. Make sure you do not violate any copyright laws (which you can avoid by shooting your own footage).

**Problem Formulation**

1. **Formulate a problem you want to solve.** It must be related to electromagnetics.
2. **Research your topic.** Find at least one paper in a technical journal (and include a copy with your writeup) that describes the problem you are investigating. It does not have to (in fact probably will not) describe how to apply a numerical method to the problem.
3. **Determine your solution / modeling approach.** Which numerical method will you choose, and why? Give a list of the advantages and disadvantages of the methods you have learned (FDTD, MoM, FEM) for your particular application. What size model is realistic for your application, and can you realistically create the model in the amount of time allotted in this class? Simplify your model as needed, and explain your simplifications.
4. **Find out what you need to know:** What are the parameters of the model that you will need? Do you need to know electrical properties of some materials (like the human body or ground or concrete or anything else)? Make sure you use the correct values appropriate for your frequency range of interest. What type of source function will you use? (What frequencies or pulse shapes, what is the spatial distribution, etc.). What will be your grid resolution and time step increment?

**Model Development:**

1. **Prepare your model:** Plan out your model in detail before programming anything. Create some illustrations on paper to include in your final report.
2. **Develop code or learn to use software:** Develop the software you will use OR learn to use existing software packages as appropriate for your project.

Software packages available at the U include the following (you are welcome to use other EM software if you have access to it and it is an FDTD, MoM, or FEM solver. Note that some additional softwares are free, such as the FDTD Meep code, as listed on the Wiki page for FDTD):

   a. **XFDTD** -- 3D FDTD software with GUI. For on-line tutorial see: [www.ece.utah.edu/~cfurse](http://www.ece.utah.edu/~cfurse) (Then click TUTORIALS and XFDTD). Available in the sun lab.
   b. **Momentum** -- Method of Moments code installed as part of Agilent ADS package. For on-line tutorial see: [www.ece.utah.edu/~cfurse](http://www.ece.utah.edu/~cfurse) (Then click TUTORIALS and select ADS patch antenna tutorials. If you are not familiar with ADS, you will
need to start with the stub matching tutorial and work through the whole set.)  
Available in the microwave lab.

c. ANSYS Finite Element solver. Available in CADE lab.

Analysis and Results:
1. **Use your software to analyze the problem you have selected.** Generate graphics illustrating your results. Do your results make sense? Are they what you were expecting?
2. **Conclusion and future directions.** What are your conclusions from your modeling methodology and results? If you had more time (or funding), in what direction would you take your work and what would you do next?

Final Report and Video:
1. **Prepare a video on your project.** This video will be shown to the class during the regular final exam time. It should be 3-5 min. in length and should provide both an overview of your topic and information about your modeling methodology and results.  
Note that the Marriott Library has numerous computer systems that have a variety of video editing apps, from iMovie to Final Cut Pro, plus compression and audio editing software. If you don’t already have a handheld video recorder or movie recording capability on your phone, you can check out equipment from the campus Instructional Media Services (IMS):  
[http://ims.utah.edu/audiovisual_distribution/audiovisual_dis...etc](http://ims.utah.edu/audiovisual_distribution/audiovisual_dis...etc)
2. **Prepare a final report.** The final report should include the following: an overview of your topic, the problem / question you set out to answer, your approach, model, results, and conclusion / future directions. Include well-documented computer programs (if you wrote it yourself) or well-kept (DETAILED!) notes on how you used/applied existing software. Also include DETAILED information on your model (sketches, figures, printouts from computer meshes, electrical properties, assumptions, etc.), a summary of your results, and ANYTHING else that would be needed for another student to follow your tracks. Projects from this class may be expanded into future senior projects or research projects, so PLEASE help a fellow student with all of the notes you can. Assuming you include enough information on your project / ideas, you will be included as a coauthor on any resulting publications that stem from your project.

**VIDEO PRESENTATIONS:** Bring a copy of your video to show to the class during the final exam period. All students MUST attend. Each video will be followed by a short question and answer period.  
Also please give Dr. Simpson a CD with your codes, results, video, final report, etc. at the beginning of the final exam time.

**Some Project ideas:**

Develop a PML-type boundary condition for a 2-D hexagonal FDTD grid  
Design a better antenna for MRI  
Develop an improved ground penetrating radar system  
Improve detection of improvised explosive devices  
Apply stochastic FDTD to a problem