The following lab will introduce you to the basic concepts of Ground-Penetrating Radar (GPR) in part I. In part II, we will conduct a field geophysical survey in order to identify unmarked graves and interpret the basic geology in the subsurface. You will process the survey data, and then provide a written interpretation of the collected data. This assignment must be handed in as a hard copy. No digital copies will be accepted. **Color figures must be printed in color and be of a high quality.** There is a color printer in the lab classroom, if needed.

### Part I: Basic GPR Calculations

Before you process and think about your GPR profiles, answer the following short questions. This should help to give you some context in which to interpret your GPR results. Recall that \( v = \lambda f \).

1) Our GPR transmitter and receiver most commonly use 200 MHz antennas. This frequency is constant regardless of the material the wave is traveling through. Given that \( c \approx 3.0 \times 10^8 \frac{m}{s} \) in air, what is the wavelength (in m) of the radar wave in the air?

2) Subsurface radar velocities are typically given in m/ns. Using the value of \( c \) above, what is the speed of electromagnetic waves in air using the typical m/ns units?
3) Although the radar velocities of geologic materials vary greatly, a typical radar velocity that many GPR software packages use as default is 0.100 m/ns. Given this velocity, what is the wavelength of our 200 MHz radar wave in the subsurface?

4) Given that vertical resolution is approximately $\frac{1}{4} \lambda$, what is our expected vertical resolution?

5) Although a single antenna can send or receive a range of wavelengths quite well, an ideal antenna will have a length equal to the wavelength that it is emitting or receiving. Our 200 MHz antennas are 0.450 m long. Given this, what subsurface radar velocity (in m/ns) is ideal for our antenna?

6) What are the first two arrivals at every location on a GPR profile? Hint: these appear as two stripes across the top of all GPR sections. Describe the path that each of these waves travels from the transmitter to the receiver. Which one is always first and why?
7) List two geologic materials that are **not well-suited** for GPR surveying. State your reasoning in one sentence.

8) List two common geologic materials that **are well-suited** for GPR surveying. State your reasoning in one sentence.

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**Part II: GPR Field Data Processing and Interpretation**

Go to the course website and download the GPR field data for your lab day, unzip/extract the data, and open the .DT1 files with EKKO_View2. To get full credit, you must follow the instructions below.

1) How many subsurface velocity estimates did you make for transect 1? Calculate the average subsurface radar velocity for this transect.
2) How many subsurface velocity estimates did you make for transect 2? Calculate the average subsurface radar velocity for this transect.

3) Fill in your final EKKO View2 processing values in the table below. Warning: Do not blindly accept the default values. Nearly never are they optimal. You will have to justify some of these choices in subsequent questions.

<table>
<thead>
<tr>
<th>Transect Number</th>
<th>Attenuation</th>
<th>Start Gain</th>
<th>Max Gain</th>
<th>Max TWT on Plot (ns)</th>
<th>Average $V_{\text{radar}}$ (m/ns)</th>
<th>Number of Graves Detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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4) At the end of this lab, print out and attach your two processed GPR profiles as professional quality figures with captions. Specific instructions are below:

   a) Once you have your optimal processing settings completed, create professional quality (.png format looks best) and well-labeled figures of your GPR data and insert each one into a Microsoft Word document. Include these two figures (one per page including the caption) with your lab write up. Put your plots in landscape mode in MS Word since your GPR profiles will be wide and not that tall.

   b) Make sure to apply your best-fitting velocity to the y-axis of each transect.

   c) Chop off the noisy and unneeded portion of your data for each transect and make sure that there is approximately zero vertical exaggeration.

   d) Label the locations of graves or other geologic features, using the “insert” menu tools in Microsoft Word. For example, you can use the insert menu to insert shapes or text boxes where needed. Make sure that your annotations do not cover up your data. If you want to annotate the data a lot, that is OK, but do this in a separate figure (i.e. make a part b) below your un-annotated data. This way the reader can see the clean data with no interpretations, and then directly below is the interpreted and marked up figure.

   e) Each GPR transect should have a typed (double spaced) figure caption below it that explains your interpretations of the geophysical data. In these descriptions, you should make it clear that you understand what the data is showing and why. Be certain that your interpretations are reasonable given your data and the limitations of GPR. You should comment on how many unmarked graves were detected along with anything geologic that your data shows. I expect these captions to be a bit longer than a typical caption since this is your only place to describe your results. Make sure your figure and caption for each profile both fit on a single page.