Readings:
View the MRI safety video on the website.
Read Nishimura chapters 1 through 5 (Focus on chapters 3-5).

Problems: (In Nishimura unless otherwise stated)

1. From the safety video, answer the following questions: (a) What are helium and nitrogen used for in the MRI system? (b) What does the term quench mean? (c) Why is it dangerous to smoke near an MRI system?

2. Problem 4.3; Use MATLAB to plot out the solution for initial conditions of (a) \( M_z(0) = 0 \); (b) \( M_z(0) = -M_0/2 \); and (c) \( M_z(0) = -M_0 \). Assume a \( T_1 \) of 1 second.

3. Consider the gradient waveforms shown in the figure on the next page. The full waveforms are shown in panels (a) and (b), and zoomed-in views are shown in (c) and (d). The analog-to-digital converter (ADC) is turned on during the flat parts of the readout (Gx) gradients with a sampling rate of \( \Delta t \).
   (a) Determine the sequence parameters (G1, G2 and G3, and \( \Delta t \)) to achieve the following image specifications: FOV\(_x\) = FOV\(_y\) = 192mm, \( \delta_x = 3 \) mm and \( \delta_y = 24 \) mm.
   (b) Draw the k-space trajectory (make sure to label units correctly).

4. **MATLAB exercise 1**. In this exercise you will generate figures similar to those in Figure 5.7. Consider a uniform object with FOV\(_x\) = 4cm; and FOV\(_y\) = 2cm. The desired resolution is 0.5cm in both the x and y directions. Define a grid for the simulation of the form \([x,y]=\text{meshgrid}([-2:dx:2],[-1:dx:1]);dx=.1\). Use the `quiver` command in MATLAB to plot out the relative phases of the spins for \( k_x \) ranging from \(-W_{k_x}/2 \) to \( W_{k_x}/2 \) in steps of \( \Delta k_x \). You may assume that \( k_y = 0 \) for your simulations. Verify that the periods of spatial variation of the spin phases are what you expect. Also, comment on the differences in spatial variation between the negative and positive frequencies. **Hint:** Define a complex exponential and then use the real and imaginary parts as inputs into the `quiver` command. You may also want to play around with the scaling parameter in the `quiver` function to adjust the length of the arrows.
(a) Gx gradient

(b) Gy gradient

(c) Gx gradient (Zoomed in)

(d) Gy gradient (Zoomed in)