HOMEWORK #5
Due in Class on Thursday 11/05/09

Readings:
View the MRI safety video on the website.
Read Nishimura chapters 1 through 5 (Focus on chapters 3-5).
Read supplementary notes by L. Hanson (up to about page 32).

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? Find a example (on the web) of a large object that's been pulled into the magnet and include a copy of the image.

2. Problem 4.3; Use MATLAB to plot out the solution for initial conditions of (a) $M_z(0) = 0$; (b) $M_z(0) = -M0/2$; and (c) $M_z(0) = -M0$.   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 Δt.
   (a) Determine the sequence parameters (G1, G2 and G3, and Δt) to achieve the following image specifications: FOV_x = 256mm; FOV_y = 192 mm, $\delta_x = 4$ 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 = 3cm; 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]=meshgrid([-1.5:dx:1.5],[-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 Δk_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)

T/2 = 320 usec

T = 640 usec

(d) Gy gradient (Zoomed in)

τ = 10 usec