

**HOMEWORK #6**  
**Due in Class on Thursday 11/29/07**

**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 2.7
3. 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.
4. Problem 4.4; For this problem, also use MATLAB to plot  $\Delta S_{xy}(t)$  and  $\Delta S_z(t)$  assuming the  $T_1$  values used in Part c. Verify that the maximums are achieved at the times you found in parts (a) and (b).
5. Problem 5.1
6. Consider the gradient waveforms shown in the figure on the last 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 ( $G_x$ ) gradients with a sampling rate of  $\Delta t$ .
  - (a) Determine the sequence parameters ( $G_1$ ,  $G_2$  and  $G_3$ , and  $\Delta t$ ) to achieve the following image specifications:  $FOV_x = FOV_y = 256\text{mm}$ ,  $\delta_x = 4\text{ mm}$  and  $\delta_y = 32\text{ mm}$ .
  - (b) Draw the k-space trajectory (make sure to label units correctly).
7. **MATLAB exercise 1.** In this exercise you will generate figures similar to those in Figure 5.7. Consider a uniform object with  $FOV_x = 4\text{cm}$ ; and  $FOV_y = 2\text{cm}$ . The desired resolution is  $0.5\text{cm}$  in both the x and y directions. Define a grid for the simulation of the form  $[x,y]=\text{meshgrid}([-2:\text{dx}:2],[-1:\text{dx}:1]);\text{dx} = .1$ . 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.
8. **MATLAB exercise 2.** In this exercise you will experiment with how different imaging parameters alter the contrast of an image. First download the file BE280A07\_hw5.mat from the course website. In this file you will find three matrices labeled csf, gm, and wm, which are the partial volume maps for cerebral spin fluid, gray matter, and white matter, respectively. Assume the values shown in the table below. Assume that your MRI system can have a minimum echo time (TE) of 3 ms and a maximum TR of 10,000ms.

Finally, assume that you are using a saturation-recovery sequence. Come up with sequence parameters that yield proton-density, T1-weighted, and T2-weighted images and use the partial volume maps to generate corresponding images. For the T1-weighted image, choose parameters that maximize the contrast between gray and white matter -- you will want to use MATLAB to search over possible TR values.

Tissue	Proton Density	T1 (ms)	T2 (ms)
Csf	1.0	4000	2000
Gray	0.85	1350	110
White	0.7	850	80

