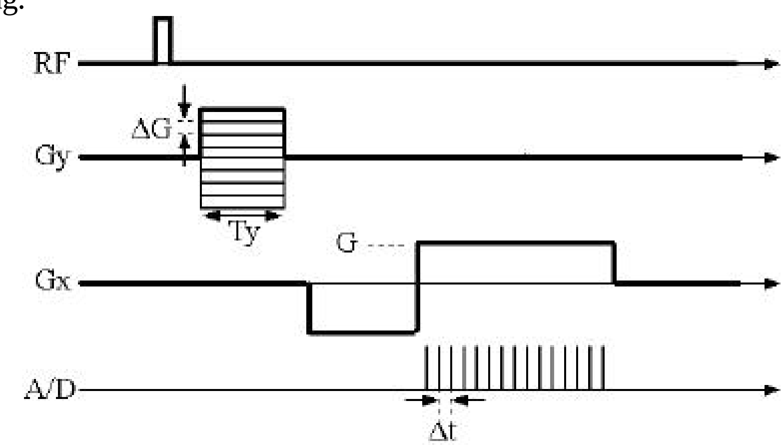
Homework #3

Due: 4/12/01

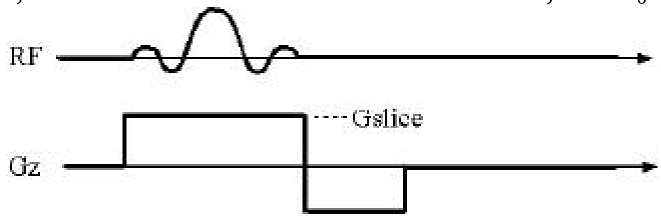
1. Consider a 1D object in the form $g(x) = m_0$ triangle(x/X), where $X = 10$ cm. Suppose we wish to image this object (in 1D) applying a 90 degree RF pulse followed by a gradient, $G_x = 10$ mT/m.
   a. What is the Fourier transform of $g(x)$?
   b. What is the space-frequency relationship (in Hz/cm) with the above G_x?
   c. Give an expression for the received signal, $s(t)$, after the RF pulse.
   d. What is the maximum spatial extent of the object? What is the maximum frequency component of the object (rotating frame)? What is the minimum required sampling rate, f_s, to prevent aliasing?
   e. Graphically, draw $s(t)$ and mark the locations of samples when they occur at the rate specified in part d.

2. Consider an object with initial magnetization $m_0(x,y) = \text{rect}(x/X, y/Y)$.
   a. Determine the 2D Fourier transform of $m_0(x,y)$.
   b. For gradient waveforms $G_x(t) = A$ and $G_y(t) = 0$, give an expression for the received signal (this is similar to 1.c. above, but we have a 2D object).
   c. Determine the minimum sample spacing in both k_x and k_y to prevent aliasing of the object.
   d. In the spin-warp pulse sequence (below), determine T_y and G (in terms of ΔG, Δt and other parameters) so that k-space is sampled finely enough to prevent aliasing.



3. Consider the pulse sequence as shown above. Let $T_y = 5$ ms, and $T_{read} = 20$ ms. Suppose our desired field of views (FOVs) are $FOV_x = FOV_y = 20$ cm and spatial resolution requirements are $\Delta x = 1$ mm and $\Delta y = 2$ mm. Determine the following:
   a. ΔG_y (in mT/m)
   b. $G_{y,max}$ (in mT/m)
   c. G_{read} (in mT/m)
   d. Δt (in ms)

4. Consider the following slice selection pulse RF and gradient pulses. Let G_{slice} = 10 mT/m, the desired slice thickness be Δz = 5 mm, and B_0 = 1.5 T.



a. Determine the center frequency and bandwidth of the RF excitation.
b. Describe an RF pulse, $B_1(t)$, that has these features.