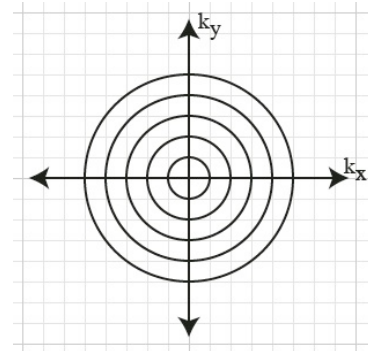


MIDTERM #2

This is an **80 minute, open book, open notes** exam. You may use the Nishimura textbook, class notes, personal notes, handouts, homework, and any other printed material. **No calculators!**

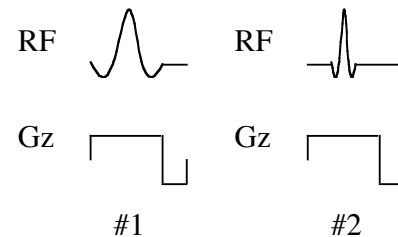
1. (20 points) You are asked to perform 2D imaging using the concentric rings trajectory shown at right. Design the gradient waveforms that would acquire one ring per TR. Use a fixed readout duration. Specify how you would modify the gradient to acquire successive rings.



Bonus points: Consider that the number of acquired rings is N_r , the radial spacing between rings is Δk_r , and the number of samples taken along each ring is N . What is the unaliased FOV?

2. (15 points) Consider a standard 2DFT imaging sequence with 30° flip angle, 5 mm slice thickness, 2 mm spatial resolution, and 20 cm FOV, that achieves an SNR of 10 in the tissue of interest. If all of the gradient amplitudes were accidentally doubled, what would be the new flip angle, slice thickness, resolution, FOV, and SNR? Describe any new potential artifacts?

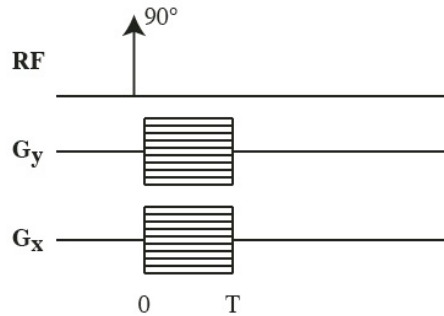
3. (15 pts) Consider the two selective excitations shown. The G_z waveforms are identical. The RF waveforms have the same amplitude but #2 is shortened by a factor of 3. RF pulse #1 has a slice thickness of 1 cm, and a tip angle of 30° . Using the small-tip approximation, find the slice thickness and tip angle of RF pulse #2?



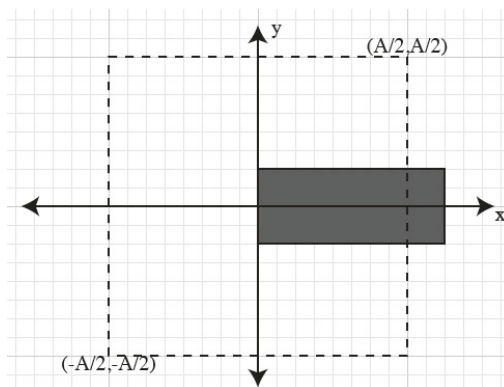
4. (15 pts) Using a saturation-recovery spin-echo sequence (page 153), is it possible to select a TE and TR such that adipose tissue ($T_1 = 300$ ms, $T_2 = 100$ ms) produces less signal than muscle ($T_1 = 1000$ ms, $T_2 = 40$ ms)? Assume that both tissues have the same proton density.

If yes, give the values of TE and TR that maximize the signal difference. If no, provide a short proof, and suggest a pulse sequence that can accomplish the task.

5. (30 pts) As shown below, a 2D MR imaging method uses phase encoding gradients for both G_x and G_y to sample one point in 2D k-space per excitation. At time T , immediately following the phase encoding lobes, a sample value of the signal is recorded without any gradients on. Assume that the image FOV is A in both the x and y directions. Ignore T_2 decay.



- (a) Given some arbitrary amplitudes, G_x and G_y , find the recorded signal value if the object is a unit impulse at (x_0, y_0) precessing on resonance (f_0 when no gradients are applied). Determine the phase difference between successive signal values as the G_x phase-encode amplitude increments.
- (b) Given some arbitrary amplitudes, G_x and G_y , find the recorded signal value if the object is a unit impulse at (x_0, y_0) precessing off-resonance ($f_0 + \Delta f$ when no gradients are applied)
- (c) For the object shown below precessing on-resonance (f_0), compare the reconstructed image of the all-phase-encode sequence with that of a conventional 2DFT sequence of the same FOV.



- (d) For the same object precessing off-resonance ($f_0 + \Delta f$), compare the reconstructed image of the all-phase-encode sequence with that of a conventional 2DFT sequence of the same FOV.
6. (5 pts) Of the major concepts covered so far in class, what have you found to be (a) most interesting, (b) least interesting, (c) most difficult to understand?