Psy 8960 - fMRI: Hands-on Training

MIDTERM EXAM

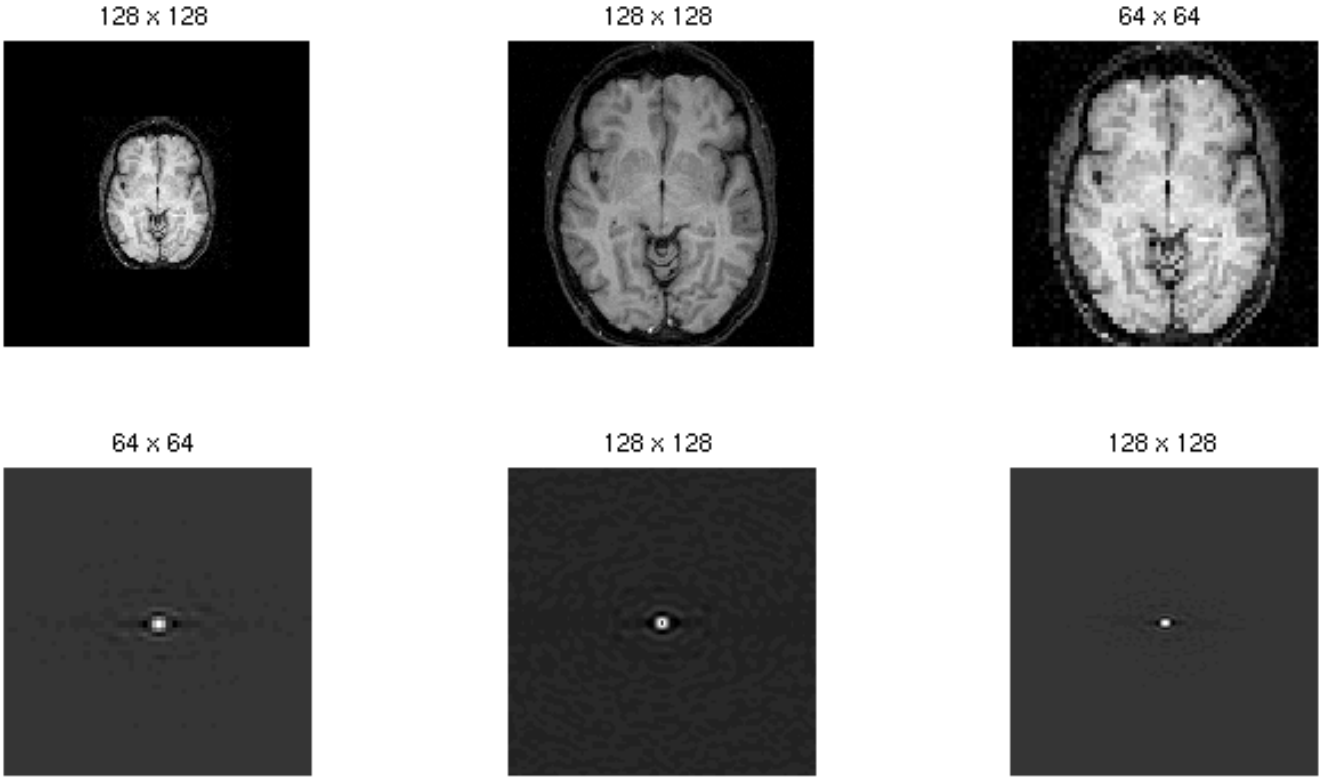
Date assigned: October 20, 2006
Date due: October 27, 2006

Each problem: 5 points
Total exam: 15% of course grade

Problem 1 (covering topics in Module1, Lectures 1 – 3)

A) For the three images of the same axial slice shown in the top row, indicate which of the k-space matrices in the bottom row is the corresponding raw data (3 points total). Key points to remember:

- k-space and image sizes must always match
- high resolution means you've sampled out farther in k-space
- large FOV means you've sampled more finely in k-space

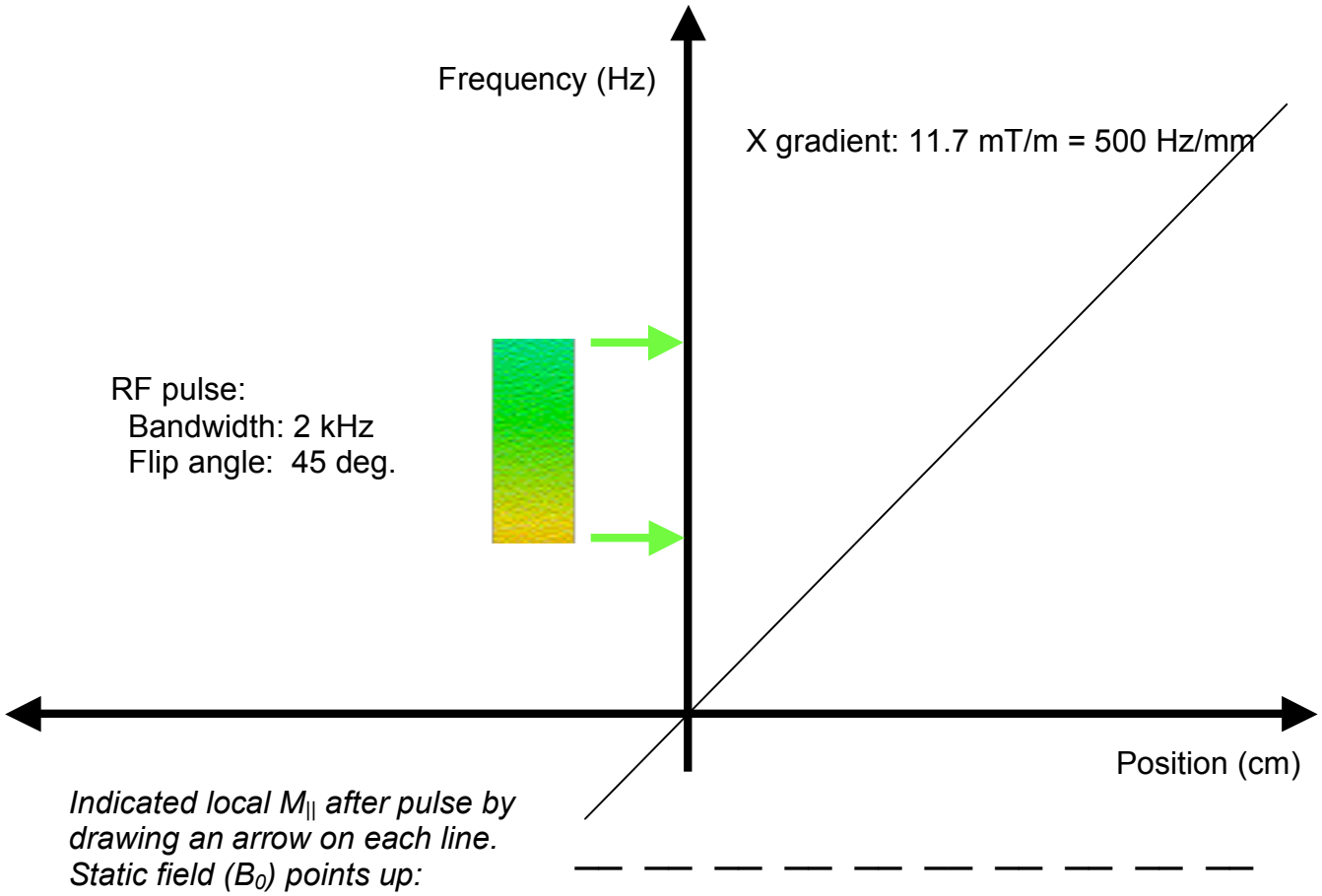


B) A spin isochromat is a collection of a large number of spins in an exactly uniform magnetic field environment. This is a useful construct because the large number of spins lets us consider the bulk magnetization of the isochromat, which behaves like a classical magnetic dipole, instead of individually considering spin-1/2 particles with

quantized states. At equilibrium, in an external magnetic field oriented along the positive z- axis, what is the orientation of the net magnetic moment of a spin isochromat (1/2 point)?

After application of a (perfect) inversion pulse, what is the orientation of the net magnetic moment of the isochromat (1/2 point)?

C) For the illustrated (perfect) 45 degree RF pulse applied in conjunction with a linear magnetic field gradient, draw (on the blanks provided) the orientation of the bulk magnetization vector associated with the spin isochromats at the indicated positions along the x axis (1 point total).



For extra credit:

How thick is the excited slice?

What is the orientation of the slice?

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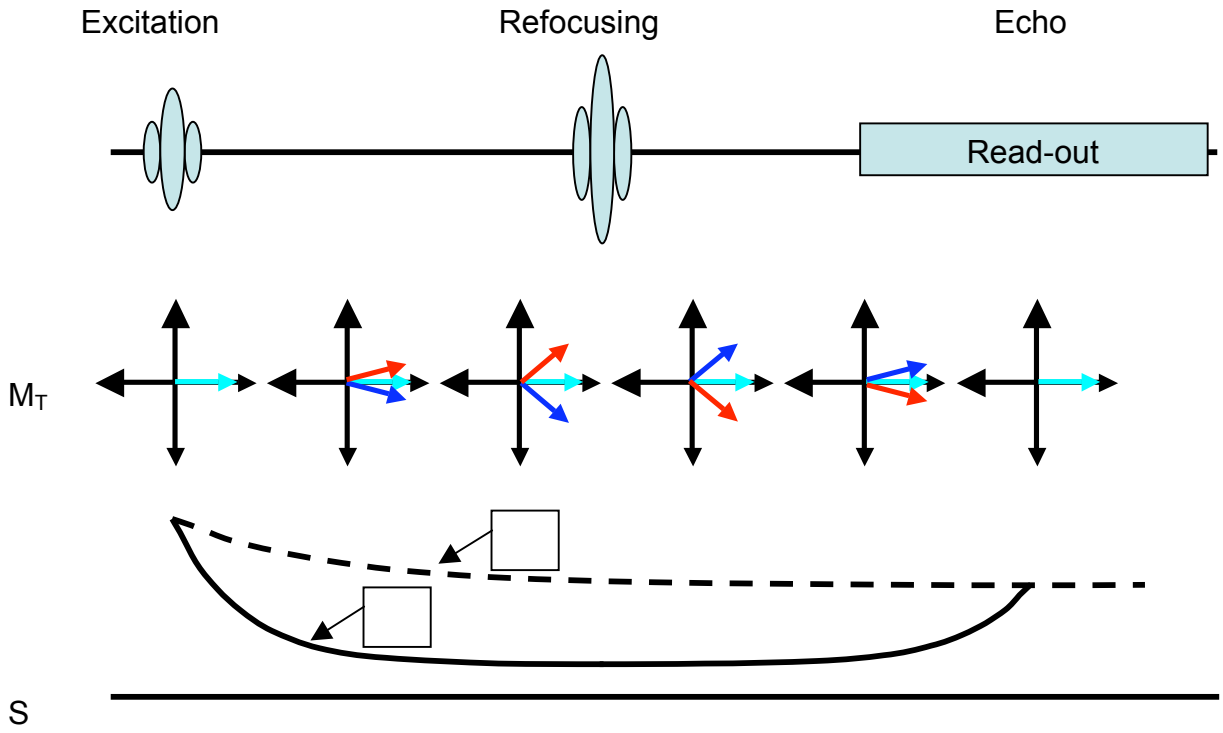
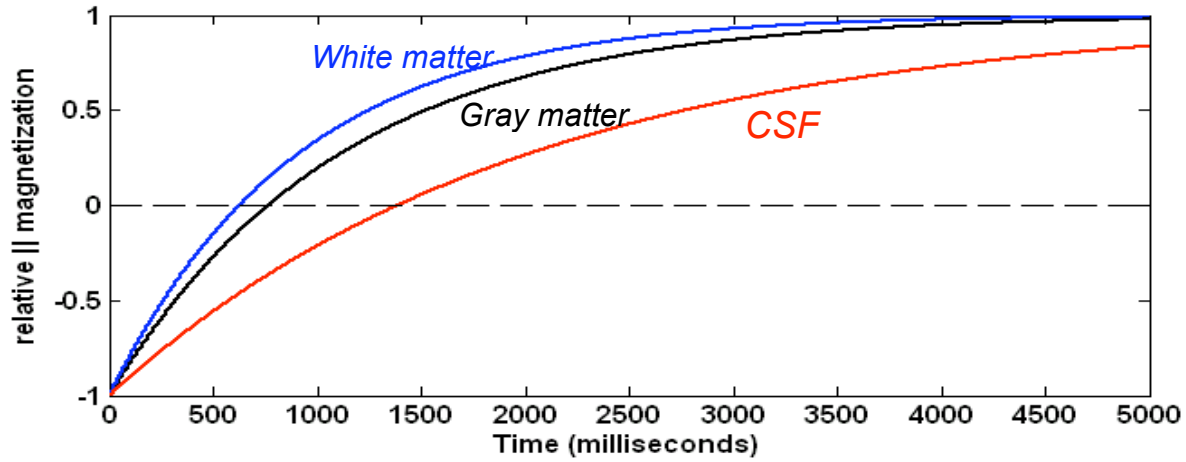
Problem 2 (covering Module 2, Lectures 4 & 5)

A) Label, on the drawing below, the T2 and T2* envelopes describing the magnitude of the net transverse magnetization generated by a collection of spin isochromats in an inhomogeneous magnetic field environment during a spin echo experiment (1 point).



B) In the inversion-recovery experiment illustrated below, what would be the appropriate time to apply an excitation pulse and read-out an image if you wanted to null the signal from the gray matter? (1 point)



C) In the data shown above, which has the longest T_1: gray matter, white matter or CSF? (1 point)

D) In the acquisition described in (b), what would be the relative image intensities of white matter and CSF in a magnitude image? (1 point)

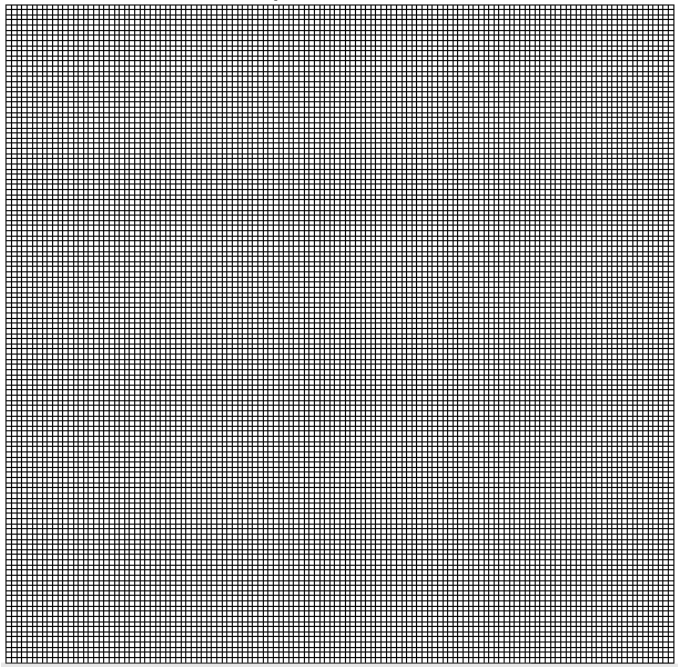
E) In any experiment, if the repetition time is very short, should the flip angle of the repeated RF pulse be large or small? (1 point)

Problem 3 (covering Module 3, Lectures 6 & 7)

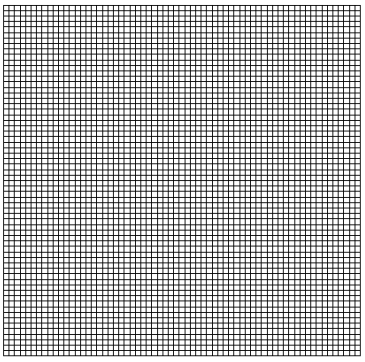
A) Label the slice-select, read-out, and phase-encode gradient axes for the two pulse sequences illustrated on the next page. Describe each pulse sequence as FLASH or EPI, Spin Echo or Gradient Echo, and Single-shot or multi-Shot. (2 points)

B) Draw on the grids provided below the k-space trajectories for each of the pulse sequences shown on the following page. Label the phase-encode direction. (2 points) (It might help to number the gradients and refocusing pulse to match k-space excursions; no need to be precise once you get read-out lines.)

Sequence 3.A.1



Sequence 3.A.2



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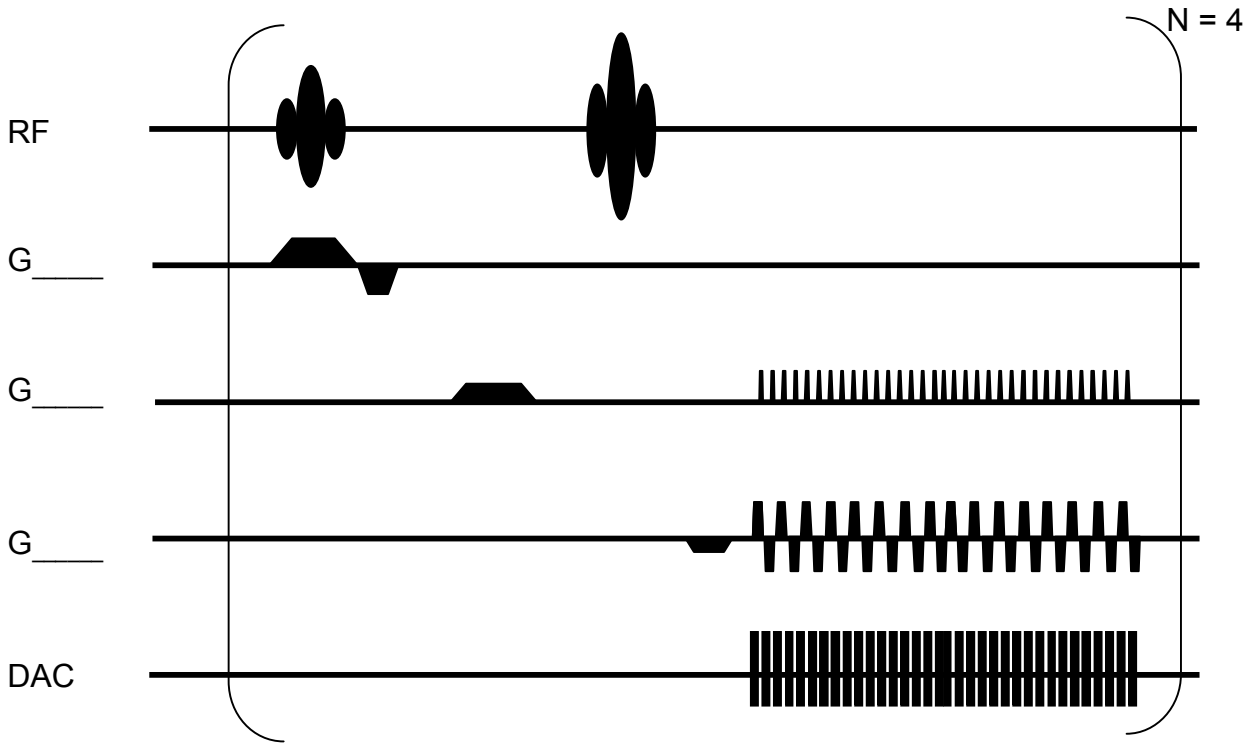
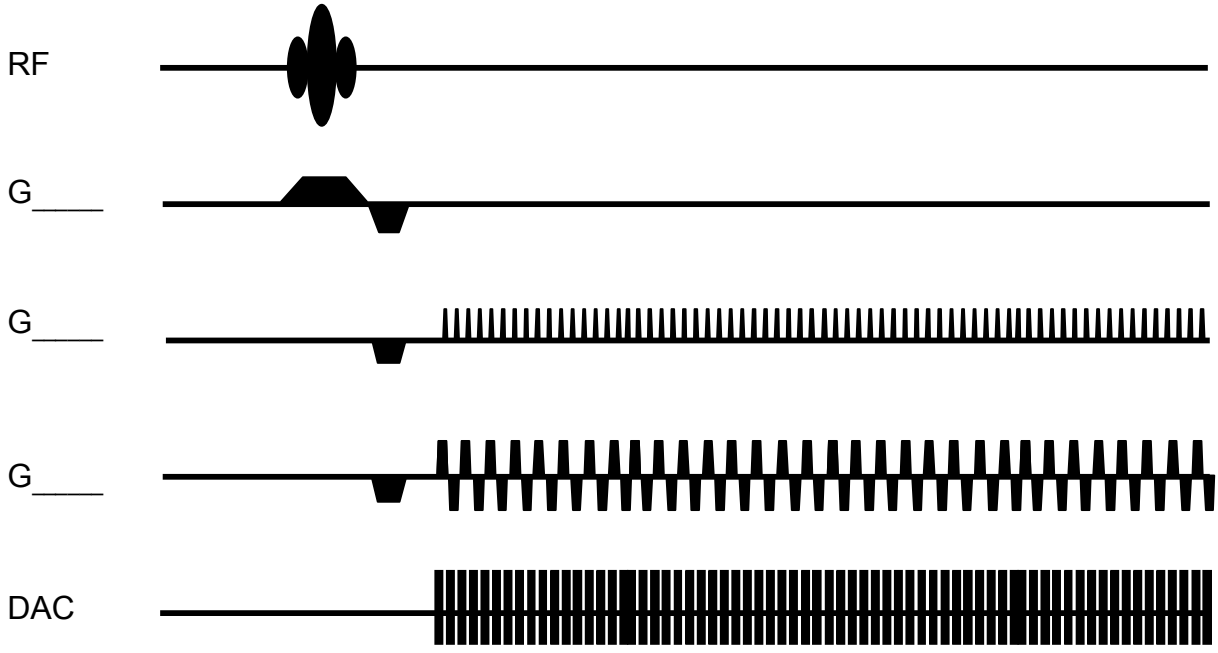
Pulse sequence 3.A.1: _____



Pulse sequence 3.A.2: _____



C) For the EPI images shown on the following pages, indicate which was acquired with pulse sequence 3.A.1, and which was acquired with pulse sequence 3.A.2. (1 point) Assume both had the same echo time during the acquisition.