Homework 5

Due: May 17th Submit: Blackboard

1. Show schematically the separate effects of: (i) a 90x°, (ii) a 180x°, (iii) a 270x°, and (iv) a 360x° pulse on thermal equilibrium magnetization using the vector model.

2. Answer true or false with 1-2 sentences of explanation:

(a) recovery of magnetization along the z-axis after a 90° pulse does not necessarily result in loss of magnetization from the xy-plane.

(b) a homogeneous static magnetic field B_0 results in a free induction decay which persists for a long time.

(c) a short tissue T1 indicates a slow spin-lattice relaxation process.

3. The operator wishes to acquire an oblique slice shown by the orientation of the white bar in Figure 1. Draw the gradient echo imaging sequence that would be run to acquire such an image. (Please draw the solution by hand or drawing tools.)

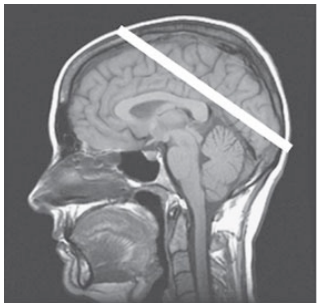

Figure 1

4. In the image shown in Figure 2, acquired using a standard spin-echo sequence, the bright signal corresponds to lipid and the lower intensity signal to water. The lipid and water signals appear spatially shifted with respect to one another.

(a) Given the facts above, which of the left/right or up/down dimensions corresponds to the frequency encoding direction, and which to the phase encoding direction? Explain your answer fully.

(b) The image is acquired at a field strength of 3 Tesla, and the black band in the image is 3 pixels wide. If the total image data size is 256 × 256, what is the overall data acquisition bandwidth? The image field-of-view is 5×5 cm: what is the strength of the frequency encoding gradient?

(c) If the frequency encoding gradient were increased by a factor of 3, what effect would this have on the imaging artifact?

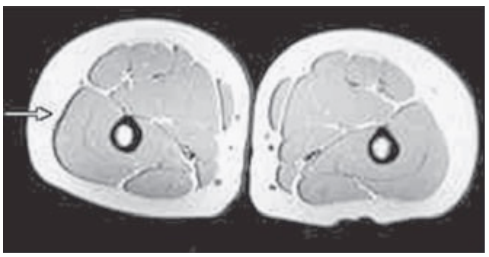

Figure 2

5. Three MRIs of the brain are acquired using identical parameters except for the TR and TE times. Three tumours (upper, middle and lower) are seen in one of the images but not in the other two, as shown in Figure 3. If the T_1 values for all the tissues (tumours and brain) are less than 2 seconds, and the T_2 values are all greater than 80 ms, describe the *relative* values of proton density, T_1 and T_2 of brain tissue and the three tumours.

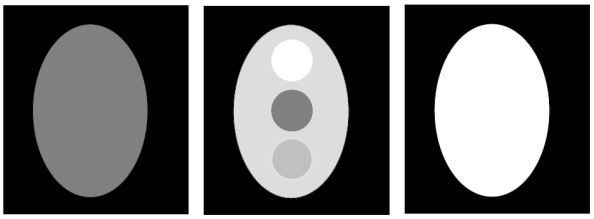

Figure 3

6. Design an EPI pulse sequence that gives the square spiral k-space trajectory shown in Figure 4. (Please draw the solution by hand or drawing tools.)

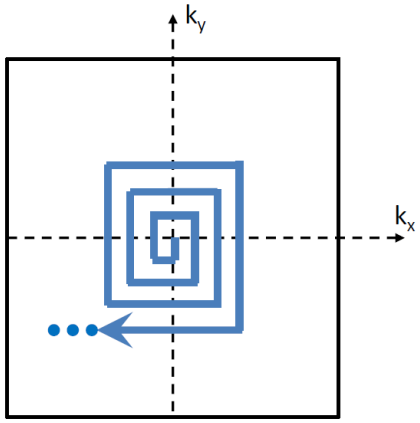

Figure 4