ECE 435/BME 403 Medical Image Processing Spring 2019
University of Victoria

Assignment 2. (6% of final course mark)
Due date: Sunday February 10 6:00 pm via CourseSpaces

Please type your answers or scan your hand-written answers. Your assignment should be submitted as one pdf file.

1. (1p) A non-uniform magnetic field *B* pointing in the z direction is applied to sample of H+ protons. The field B (in tesla) varies as a function of z (in cm)

B(z)=1+0.5z

a) Find the Larmor frequencies at z=0 and and z=1 cm.
b) Suppose at time t=0 two H+ spins located at z=0 and z=1 respectively have the same phase. At what time will these spins be in phase again?
Hint: the protons precess around the z axis with Larmor frequencies, so the minimum difference in phase for two 'aligned' spins is 2π.

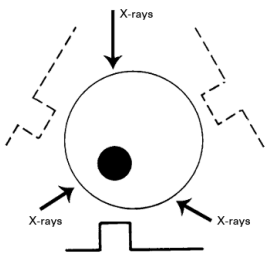
2. (0.5 p) Explain the functions of the radiofrequency transmit and receive coils in a magnetic resonance imaging system.

3. (1 p) Two fundamental steps during an MRI acquisition process are listed below. Describe and measure the effect each step has on the spins of the hydrogen atoms in the examined object.

a) Put the object in a spatially constant 3 Tesla magnetic field.

b) Send a strong electromagnetic pulse of 127.7 Mhz into the object.

4. (1p) The figure below illustrates the process of collecting projections for the generation of a CT image. Considering the same object as in the figure below, draw the diagram that corresponds to the process of image reconstruction via the back-projection algorithm. Explain how the quality of the reconstructed image improves by increasing the number of projections.



5. (0.5 p) Explain why the low Mhz range is used in ultrasound imaging.

6. (0.5 p) How much energy is reflected back when an ultrasound pulse passes from muscle to bone? How much is transmitted? (Use values for Z from Table 4.1. in the posted reading)

7. (0.5 p) An ultrasound pulse passes through soft tissue and reflects off an interface, producing an echo 0.1 ms later. How deep is the reflecting interface?

8. (1 p) If the delay between successive ultrasound pulses is 0.5 ms, what is the maximum range over which the system can successfully produce images, assuming the speed of the pulses in soft tissue is 1540 ms^{-1}. Note: The echo from one pulse should be received before the transmission of the next.