Cairo University **Midterm Exam #1**
Biomedical Engineering Department **November 27, 2004**
Medical Equipment – Part 2 **Exam Model (B)**

Student Name (in Arabic):

Section/Bench Number:

I. Please Select the correct answer to the following questions [2.5 points each]:

1. After a single 90? RF pulse, the received signal disappears after:
   a. 5 T2
   b. 5 T2*
   c. T2*
   d. T2
   e. T1

2. The Larmor frequency at the magnet isocenter of a 4T magnet when Gx= 20 mT/m is:
   a. 64 MHz
   b. 42.6 MHz
   c. 21 MHz
   d. 170 MHz
   e. 100 MHz

3. Given a particular slice selection, to change the slice profile without changing the slice position, thickness, or flip angle, one must change:
   a. RF pulse amplitude
   b. RF pulse duration
   c. RF pulse envelope
   d. RF pulse modulation
   e. Slice selection gradient

4. Given a slice selection scheme where a 10 mm slice is selected along the z-direction at z_o= 10 cm with G_z= 10 mT/m, B_0= 4 T, RF pulse amplitude= 15 mT, and with flip angle of 30?, it is possible to double the flip angle of the selected slice by,
   a. Doubling the duration
   b. Doubling the modulation
   c. Doubling the slice selection gradient
   d. Doubling the amplitude
   e. Doubling the gyromagnetic ratio

5. For a 3D FLASH pulse sequence, with TR= 20 ms, TE= 5 ms, flip angle= 15?, NEX=4, if total number of phase encoding steps needed is 16384, then the total acquisition time is:
    a. <1 minute
    b. 1 minute
    c. 5 minutes
    d. 11 minutes
    e. 22 minutes

6. In an MRI experiment, a 20 cm ? 20 cm FOV was imaged with a matrix size of 128?128, TR/TE: 1000/20 ms, and flip angle: 30?. To change the matrix size to 128?256, the acquisition time for the new experiment compared to the first will be:
    a. Double
    b. Half
    c. Four times
    d. Quarter
    e. The same

7. An MRI experiment has the following parameters, a 25 cm ? 25 cm FOV was imaged with a matrix size of 256?256, TR/TE: 3000/50 ms, and flip angle: 30?. To increase the size of the FOV in the phase encoding direction to 25 cm, one must only:
    a. Decrease the phase encoding step
    b. Increase the phase encoding step
    c. Decrease the coverage in the phase encoding direction
    d. Increase the coverage in the phase encoding direction
    e. Switch the directions of the readout and phase encoding

8. In a single slice imaging sequence, the scan parameters were: TR= 300 msec, TE=15 msec, FOV: 20cm x 20cm, Matrix 128x192, Number of slices: 1, slice thickness: 5mm, NEX: 2, flip angle: 30 degrees. The shortest total acquisition time for this sequence is approximately:
    a. 41 sec
    b. 77 sec
    c. 1.2 minute
    d. 2.4 minute
    e. 9 minutes

9. The negative gradient lobe applied right before the Readout gradient in the same direction is used to:
    a. Make phase encoding
    b. Make better slice selection
    c. Center k-space acquisition
    d. Center image
    e. Allow longer acquisition

10. In a T2*-weighted experiment, tissues with larger T2* times appear,
    a. Brighter
    b. Darker
    c. Nulled
    d. Larger
    e. Smaller

11. In a T1-weighted experiment, tissues with larger T1 times appear,
    a. Brighter
    b. Darker
    c. Nulled
    d. Larger
    e. Smaller

12. To null the fat tissues in an experiment, the following pulse sequence can be used to do that,
    a. Spin echo
    b. Partial saturation
    c. Inversion recovery
    d. All of the above
    e. None of the above

13. Net magnetization can only be observed when,
    a. it is in the rotating frame of reference
    b. it is in the lab frame
    c. it is in the equilibrium position
    d. it is in the same direction as B_0.
    e. it is in the transverse plane

14. A T1-weighted pulse sequence can be,
    a. A spin-echo sequence with long TR and long TE
    b. A spin-echo sequence with short TR and long TE
    c. A gradient sequence with long TR and long TE
    d. A gradient echo sequence with short TR and short TE
    e. A spin-echo sequence with long TR and short TE

15. The key component for spatial encoding in MRI systems is,
    a. Static magnetic field
    b. RF pulses
    c. Shim coils
    d. Magnetic field gradients
    e. Gantry

16. A material that is chemically shifted from water by 6.4 kHz has a different resonance frequency at 1.5 T from that of water by approximately,

a. 1 ppm
b. 2 ppm.
c. 10 ppm
d. 100 ppm
e. 200 ppm

17. Given a 60? RF pulse that is implemented using a Sinc time domain envelope using a slice selection gradient G_z=15mT/m at 1.5T to excite a 3mm slice centered at the magnet isocenter, we can derive another RF pulse to excite a similar slice profile at the same position with half the slice thickness by modifying the current pulse as follows,

a. Increase the modulation frequency by 6.4kHz.
b. Shift the slice selection gradient by 1 cm.
c. Double the time domain width of the RF pulse.
d. Decrease the amplitude of the RF pulse by one half.
e. Change the RF envelope function.

18. The signal decays fast in free induction decay because of,

a. Spin-spin relaxation
b. Spin lattice relaxation
c. Spin dephasing
d. Magnetization transfer
e. Spin echo formation

19. The common cause of aliasing artifact is:

a. The absence of sampling in RO direction
b. The absence of sampling in PE direction
c. The under-sampling in PE direction
d. The under-sampling of the slice selection
e. The over-sampling of both the PE and RO directions

20. Cross-talk is the result of:

a. Overlapping between adjacent slice profiles
b. Overlapping of gradients
c. Interference in signal lines
d. Interference between gradient coils
e. Overlapping of RF pulses

21. In designing an RF pulse to select a 5 mm slice in a 4T magnet, if the slice selection gradient is set at 10 mT/m and the desired flip angle is ?/3, a proper design for the duration of a rectangular RF pulse can be selected approximately as:

a. 500 nsec
b. 1 msec
c. 2 msec
d. 100 nsec
e. 5 msec

22. To collect 128 rows in the k-space, each row takes an amount of time that is equal to:
    a. Scan time
    b. TE period
    c. TR period
    d. RF Excitation
    e. TI period

23. The field of view is primarily determined by:
    a. The number of acquired k-space samples
    b. The size of the reception coils
    c. The sampling bandwidth and read-out gradient
    d. SNR
    e. The image resolution.

24. Increasing the voxel size in the phase encoding direction at same coverage will:
    a. Cause aliasing
    b. Increase the scan time
    c. Decrease the scan time
    d. Have no effect on the scan time
    e. Cause cross-talk

25. The k-space trajectory of a sequence is completely determined by:
    a. The history of the RF pulses
    b. The history of the gradients after the RF pulse
    c. The imaging parameters such as TR/TE.
    d. The sequence type (spin echo, gradient echo, or inversion recovery)
    e. All of the above

26. The FOV in the read-out direction depends on,
    a. Sampling duration
    b. Sampling dynamic range
    c. Sampling preparation
    d. Sampling bandwidth
    e. Sampling hardware

27. The received MR signal immediately after a perfect 180? RF pulse is expected to be,
    a. Zero
    b. T1-weighted
    c. T2*-weighted
    d. T2-weighted
    e. Of mixed T1/T2 weighting.

28. The implementation of FOV selection in MRI systems is done through,
    a. Proper selection of k-space coverage in in k_x and k_y directions.
    b. Proper positioning of the patient inside the magnet.
    c. Proper adjustment of the image reconstruction software.
    d. Proper selection of the Larmor frequencies inside the patient.
    e. Proper selection of sampling steps in k_x and k_y directions.

29. To measure T2, we usually use,
    a. Inversion recovery pulse sequence
    b. Gradient echo pulse sequence
    c. Spin echo pulse sequence
    d. All of the above
    e. None of the above

30. To change the flip angle only of an RF pulse, one can do the following:
    a. Change the modulation of the RF pulse
    b. Change the duration of the RF pulse
    c. Change the bandwidth of the RF pulse
    d. Change the amplitude of the RF pulse
    e. Change the direction of the X and Y RF coils

II. Please Answer the following with either True (T) or False (F) [1.5 points each]:

31. The MR signal depends linearly on the RF flip angle.
32. Frequency encoding can be used to spatially encode two directions simultaneously.
33. The coverage of the k-space determines the resolution of the image.
34. The selection of FOV and resolution in the readout and phase encoding directions can be different in general.
35. The k-space is the Fourier domain of the image.
36. The use of Sinc RF pulses reduces cross-talk compared to rectangular pulses.
37. Spin echo sequences can be used to measure T1 characteristics of a tissue.
38. It is possible to control the slice selection orientation to be parallel to y-z plane instead of the usual x-y plane by applying the slice selection gradient in the x direction.
39. Spectroscopy can be used to map different nuclei simultaneously.
40. Acquisition time depends linearly on the total number of phase encoding steps used in a sequence.

III. Asnwer the following questions [10 points]:

41. Draw a properly labeled T2-weighted imaging sequence that acquires the shown k-space trajectory: