BIOMEDICAL ENGINEERING DEPARTMENT
4TH YEAR MEDICAL EQUIPMENT

MRI MIDTERM EXAM 1

December

SOLVE AS MUCH AS YOU CAN.

1. [3 points] In a T2-weighted image, tissues with long T2 appear:
One) Dark b) Bright c) Empty d) Suppressed e) Homogeneous

2. [3 points] Signal received from a selected slice depends on:
a) Magnetic field gradient strength b) Static magnetic field strength
c) RF pulse center frequency d) RF pulse bandwidth
e) RF pulse amplitude and duration

3. [3 points] STIR imaging sequence is mainly used for:
a) T2*-weighted imaging b) Enhancing the contrast of a particular tissue
c) Nulling the signal from a particular tissue type d) Reducing the scan time
e) Increasing the scan time

4. [3 points] TR primarily controls the following contrast:
a) T1-weighting b) T2-weighting c) T2*-weighting
d) Inversion recovery e) Spin-echo

5. [3 points] The primary reason for choosing a magnetic field in the Tesla range for MRI is:
a) To allow for a stronger force on patients
b) To be able to apply the superconductor technology in this area
c) To allow for a stronger magnetic resonance signal
d) The safety of having a strong magnetic field
e) To fit large patients

6. [3 points] The shim coils are used for:
a) Adjusting the current in the superconductors of the static field magnet
b) Trimming the static field B0 for a better homogeneity across the field of view
c) To generate magnetic field gradient for spatial encoding
d) To increase the strength of the static magnetic field
e) To generate the B1 field of the RF pulse

7. [3 points] The Larmor frequency of the iso-center of a 1.5 Tesla magnet is:
a) 63.9 MHz b)42.6 MHz c) 28.4 MHz d) 21.3 MHz e) 85.2 MHz

8. [3 points] Phase encoding cannot be applied for:
a) Spatial encoding in one dimension b) Spatial encoding in two dimensions
c) Spatial encoding in three dimensions d) Fourier imaging
e) Slice selection

9. [3 points] Inversion time TI in inversion recovery is computed such that:
a) proton density of a tissue is zero b) z-magnetization of a certain tissue type is zero
c) relaxation of a particular tissue type is zero d) the T2 weighting is maximum
e) the transverse magnetization is zero

10. [3 points] The magnetic field gradients must be:
a) Nonlinear b) Piecewise linear c) Constant
d) Stronger than static field e) Stronger than B1 field

11. [3 points] The RF pulse application system uses:
a) Three coils in x, y and z directions
b) Two Coils in the x and y directions
c) One coil in the x direction
d) One coil in the y direction
e) One coil in the z direction

12. [3 points] Given a slice selection system, to increase the slice width from 3 mm to 6mm, the easiest method to do that in practice is:
a) to decrease the RF pulse bandwidth
b) to decrease the RF pulse duration
c) to increase the magnitude of the RF pulse
d) to increase the slope of the slice selection gradient
e) to decrease the slope of the slice selection gradient

13. [3 points] The Frequency encoding works by:
a) Encoding the frequency of the RF pulse
b) Encoding the Larmor frequency of the spins right after the RF pulse
c) Encoding the Larmor frequency of the spins during the acquisition period
d) Encoding the phase of the received signal
e) Encoding the slice position to be acquired

14. [3 points] A single RF in a Fourier imaging pulse sequence enables the acquisition of:
a) One point in the image
b) One line in the image
c) One point in the frequency spectrum of the image
d) One line in the frequency spectrum of the image
e) A collection of points in the image

15. [3 points] A T2*-weighted pulse sequence can be:
a) A spin-echo sequence with long TR and long TE
b) A partial-flip sequence with long TR and short TE
c) A spin-echo sequence with short TR and long TE
d) A partial-flip sequence with long TR and long TE
e) A spin-echo sequence with long TR and short TE

16. [3 points] A T1-weighted image can be obtain by adjusting the imaging parameters such that:
a) T1 is long and T2 is short
b) TR is long and TE is short
c) TR is short and TE is short
d) TR is long and TE is long
e) T1 is short and T2 is long

17. [3 points] The most common RF pulse envelope is -----, and is used to obtain a desirable slice profile approximating a ------- .
a) Gate , Gate
b) Gate , Sinc
c) Sinc , Sinc
d) Sinc , Gate
e) Gaussian , Gate

18. [3 points] Cross-talk is the result of:
a) Interference in signal lines
b) Interference between gradient coils
c) Overlapping between adjacent slice profiles
d) Overlapping of gradients
e) Overlapping of RF pulses

19. [3 points] A slice selection gradient of 5 mT/m if combined with an RF pulse of bandwidth of 1kHz will select a slice of thickness:
a) 1 cm
b) 1 mm
c) 2 mm
d) 5 mm
e) 8 mm

20. [3 points] Resolution of the image in the frequency encoding direction depends on:
a) the sampling rate and the number of samples of the received signal
b) the number of phase encoding steps
c) the slice thickness
d) the slice profile
e) the size of the object

21. [3 points] The negative gradient lobe applied right after the RF pulse in the slice selection direction is called:
a) Slice selection lobe
b) Slice refocussing lobe
c) Phase encoding
d) Frequency encoding
e) Inversion time

22. [3 points] To acquire a 128x256 image, it is fastest to use:
a) slice selection, phase and frequency encoding
b) slice selection and phase encoding in two dimensions
c) slice selection and frequency encoding in two dimensions
d) frequency encoding in three dimensions
e) phase encoding in three dimensions

23. [3 points] The shift between the Larmor frequency of the isocenter and a location 2 cm away from the isocenter when the applied gradient is 10 mT/m is
a) 1 kHz b) 17 kHz c) 8.5 kHz d) 34 kHz e) Other: ------

24. [3 points] The phase encoding gradient is applied:
a) during the RF pulse b) during the frequency encoding gradient
c) before the RF pulse d) after the frequency encoding gradient
e) Between the RF pulse and the frequency encoding gradient

25. [3 points] Image contrast is completely determined by:
a) slice selection b) phase encoding c) frequency encoding
d) TR/TE combination e) RF pulse

26. [3 points] Longitudinal relaxation is longer in which type of tissues?
a) water > solids > fat b) fat > solids > water c) solids > water > fat
d) water > fat > solids e) solids = water = fat

27. [10 points] Design an imaging sequence to acquire a 2-D image of the brain of a human subject at the level of the base of the brain. The sequence must allow for maximum contrast while keeping the acquisition time minimum to allow a subsequent segmentation stage to work well. The components to be segmented are: gray matter, white matter, CSF, and fat. The image parameters should be: matrix: 256x256, FOV: 20 cm x 20 cm, NEX=1/2. [Hint: brain components vary in T1, T2, T2* and PD. Select the one that gives the minimum acquisition time]

28. [10 points] It is required to select a 5 mm slice that is centered at -5 cm from the isocenter of a 1 Tesla magnet. Design RF pulse parameters that would provide a 30 degree flip for such a slice. The magnet has a max gradient strength of 20 mT/m, and RF pulse shapes include rectangular, Gaussian, Hamming, and Hanning profiles (assume whichever is most convenient for your calculations). Assume the slice orientation to be sagittal (i.e., parallel to y-z plane).

29. [9 points] Draw properly labeled imaging sequences for:
One) a T2*-weighted imaging using Fourier imaging.
Two) an inversion recovery pulse sequence
Three) a spin-echo pulse sequence
Illustrate the k-space trajectory of each sequence.

30. [5 points] In a special imaging sequence, it is required to simultaneously select two slices at the same time using the usual RF pulse/gradient systems available on commercial MRI systems. Design an RF pulse that can be used to excite two transverse (x-y) 1 cm slices center at +1 cm and –2 cm. Assume any missing information.

BEST OF LUCK