PART B: MRI AND COMPUTED IMAGING

SOLVE AS MUCH AS YOU CAN.

I. Answer the following questions by selecting ONE choice:

B1. [1.5 points] MIP is a method for:
One)   Reconstructing MRA volumes
Two)   Visualizing images of vessels from acquired MRA volume
Three) Acquiring MRA volumes
Four)   Reducing artifacts in MRA
Five)   Reducing saturation artifacts in MRA

B2. [1.5 points] In MRA, to overcome the saturation artifacts in 3D and the low SNR in 2D TOF acquisition, the following technique can be used:
One)   Black blood MRA
Two)   Bright Blood MRA
Three) MIP
Four)   MOTSA
Five)   TONE

B3. [1.5 points] STIR imaging sequence is used to:
One)   Label the fat component for subsequent segmentation
Two)   Make the fat component contrast higher for better visualization
Three) Make the fat components in the image disappear
Four)   Improve the signal-to-noise ratio in fat areas
Five)   Provide images of only fat tissues

B4. [1.5 points] To acquire a T1-weighted image, we must use:
One)   Spin echo sequence with long TR and Long TE
Two)   Spin echo sequence with short TR and short TE
Three) Spin echo sequence with long TR and short TE
Four)   Gradient echo sequence with long TR and long TE
Five)   Gradient echo sequence with short TR and short TE

B5. [1.5 points] Increasing the resolution of a sequence for the same FOV in a phase encoding direction results in:
One)   The same SNR
Two)   A higher SNR
Three) A lower SNR
Four)   Unpredictable change in SNR
Five)   Other: ……..

B6. [1.5 points] In order to increase the resolution for a given FOV in the frequency encoding direction, the best SNR is obtained when this increase is obtained using:
One)   A higher BW at the same read-out gradient and same sampling duration
Two)   The same BW at a lower read-out gradient and higher sampling duration
Three) A higher BW at a lower read-out gradient and same sampling duration
Four)   The same BW at the same read-out gradient and higher sampling duration
Five)   A higher BW at a lower read-out gradient and higher sampling duration

B7. [1.5 points] For the same matrix (N x N x N) and FOV, the ratio of the SNR for 3D acquisition to that for multi-slice acquisition is,

One) N

Two) $1/N$

Three) $\sqrt{N}$

Four) $1/\sqrt{N}$

Five) 1

B8. [1.5 points] Aliasing artifact in the phase encoding direction results from:

One) A number of phase encoding steps that is too small

Two) A number of phase encoding steps that is too large

Three) A phase encoding step that is too small

Four) A phase encoding step that is too large

Five) Under-sampling the received time-domain echoes

B9. [1.5 points] Truncation artifact results in images characterized by:

One) Apparent ringing

Two) Ghosts

Three) Geometric distortion

Four) Venetian blind distortion

Five) Saturation effects

B10. [1.5 points] The special requirements of mammography are:

One) High energy x-ray, high spatial resolution, and long exposure time

Two) Low energy x-ray, high spatial resolution and short exposure time

Three) High energy x-ray and high spatial resolution at any exposure time

Four) Low energy x-ray at any resolution and exposure time

Five) Medium energy x-ray and low spatial resolution at short exposure time

B11. [1.5 points] If a material with 1.5 times the attenuation coefficient of water has a CT number of 500, the CT number of another material that is 0.75 that of water is,

One) -500

Two) -250

Three) 250

Four) 1000

Five) -1000

B12. [1.5 points] Dynamic spatial reconstruction system is characterized by:

a) Fast acquisition and reconstruction of 3D volumes using computed tomography

b) Real-time visualization of acquired 3D volumes

c) Dynamic imaging in MRI

d) Spatial-temporal analysis in functional imaging

e) A fast processing for MRI reconstruction

B13. [1.5 points] PET technique relies on:

One) Tomographic reconstruction of attenuation coefficients maps

Two) Tomographic reconstruction of photon emission sources

Three) Tomographic reconstruction of annihilation radiation using coincidence detection

Four) Tomographic reconstruction of attenuated alpha particles

Five) Tomographic reconstruction of attenuated beta particles

B14. [1.5 points] SPECT reconstruction is more difficult than conventional CT reconstruction because:
One)   The detectors used to collect the data are less efficient
Two)   The injected radioactive materials are difficult to handle
Three) It is required to compute both attenuation and photon source intensity maps
Four)   It is required to compute higher resolution images
Five)   The computers used in SPECT are less sophisticated

B15. [1.5 points] Longitudinal relaxation is longer in which type of tissues?
One)   water > solids > fat
Two)   fat > solids > water
Three) solids > water > fat
Four)   water > fat > solids
Five)   solids = water = fat

B16. [1.5 points] A gradient echo sequence with a short TR and long TE has,
One)   T1-weighted contrast only
Two)   T2-weighted contrast only
Three) T2*-weighted contrast only
Four)   Mixed T1- and T2-weighted contrast
Five)   Mixed T1- and T2*-weighted contrast

B17. [1.5 points] It is required to collect a T1-weighted image of a small 4cm x 4cm area within the brain tissue at maximum signal-to-noise ratio. The outline of the brain fits into a 20cm x 20cm FOV and is fairly symmetric within this area. The center of the region of interest is away from the magnet isocenter by 2 cm in the x-direction and 1 cm in the y-direction.away. The optimal FOV to be used in this case should be:
One)   20cm x 20cm
Two)   4cm x 4cm
Three) 14cm x 13cm
Four)   16cm x 15cm
Five)   Other: ……..

B18. [1.5 points] In designing an RF pulse to select a 5mm slice in a 1.5T magnet, if the slice selection gradient is set at 5mT/m and the desired flip angle is $\pi/6$, a proper design for the duration of a rectangular RF pulse can be selected approximately as:
One)   1 msec
Two)   2 msec
Three) 8 nsec
Four)   1 nsec
Five)   Other: ……

B19. [1.5 points] To acquire an oblique slice that makes an angle of 45 degrees with x-, y- and z-axes, the slice selection design consists of:
One)   Three similar RF pulses in x-, y-, and z-directions with no gradients
Two)   One RF pulse and no gradients
Three) Two RF pulses in x- and y-directions and a gradient in z-direction
Four)   One RF pulse and equal gradients in x-, y-, and z-directions
Five)   Other: ……

B20. [1.5 points] In a multi-slice TOF MRA imaging sequence, the scan parameters were: TR/TE: 300/20 msec, FOV: 20cm x 20cm, Matrix 256x192, Number of slices: 128, slice thickness: 5mm, NEX: 2, flip angle: 30 degrees. The shortest total acquisition time for this sequence is approximately:
One)   18 minutes
Two)   245 minutes
Three) 2 minutes
Four)   9 minutes
Five)   Other: …….

B21. [1.5 points] In TOF MRA, the inherent contrast mechanism used to distinguish the vessels is:
One)   Gadolinium
Two)   Fluid nature of the blood
Three) T2 characteristics of the blood
Four)   Blood motion
Five)   RBCs

B22. [1.5 points] The main disadvantage of half NEX acquisition is:
One)   Its low SNR
Two)   Its fast acquisition time
Three) Its inherent T1-weighting
Four)   Its low contrast
Five)   Its severe motion artifacts

B23. [1.5 points] A fundamental limitation of MRI is:
One)   Its inability to image soft tissues accurately
Two)   Its inherent low SNR
Three) Its inability to image tissues near air or bone interfaces
Four)   Its low signal because of attenuation effects
Five)   Its volumetric acquisition

B24. [1.5 points] The k-space trajectory can be fully determined by:
One)   Knowing the RF pulse and the slice selection gradients
Two)   Knowing the full gradient history within the selected slice
Three) Knowing the data acquisition period relative to applied gradients
Four)   Both a) and b)
Five)   Both b) and c)

II. Answer the following questions by either TRUE or FALSE:

B25. [1 point] The B0 magnetic field is turned on and off to start and end a scan
B26. [1 point] The shim coils are used to improve the homogeneity of B0 field
B27. [1 point] The B1 field is generated using two coils in the x- and y-directions
B28. [1 point] The k-space trajectory depends on the flip angle of the RF pulse
B29. [1 point] Half NEX sequences are used to improve SNR
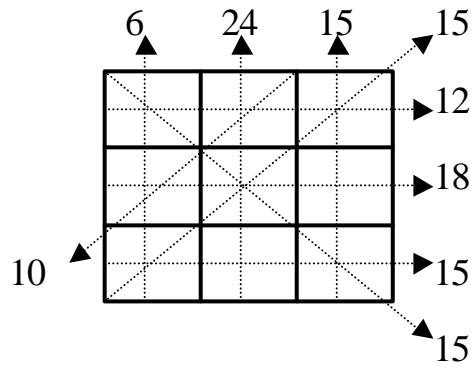B30. [1 point] Cross-talk results from overlapped slice profiles
B31. 1 point] Partial volume artifacts results from small slice thickness

B32. [1 point] T2* is completely independent from T2 relaxation

B33. [1 point] Spin echo is used only when T2-weighting is desired

B34. [1 point] CT can be used effectively near air or bone tissue interfaces

B35. [4 points] Draw a properly labeled T2*-weighted sequence (a) and T1-weighted sequence (b) that have the shown k-space trajectories:

(a)   (b)
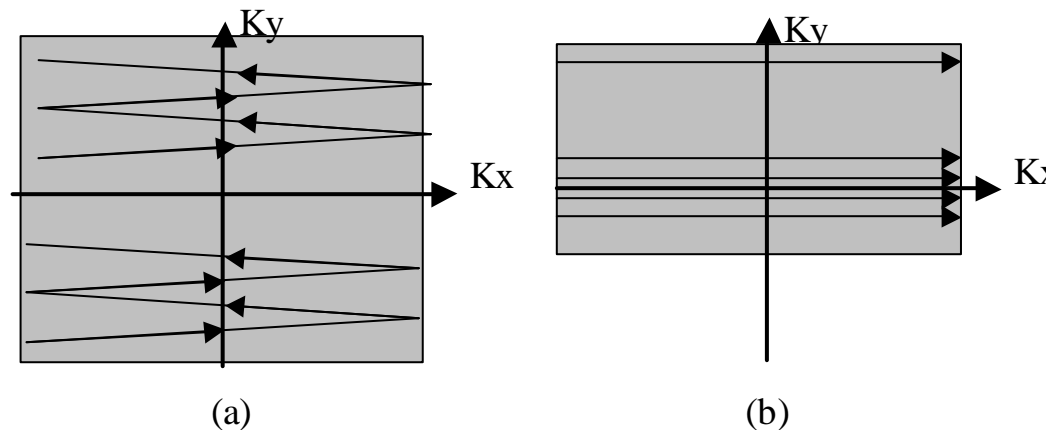
B36. [3 points] Solve the following reconstruction problem using ART:

BEST OF LUCK