

Fourth Year Biomedical Equipment Mid-Term Exam (May 2002)
Time Allowed: 1 ½Hours

PART I. Choose the best answer for each of the following questions (2 points each)

1. The net magnetization refers to
 - a) The remaining magnetization after $T2^*$ decay.
 - b) The difference between spins pointing with B_0 and those pointing against B_0
 - c) The magnetization in the transverse plane at equilibrium.

2. As the static magnetic field becomes higher, the MR signal from is expected to,
 - a) Increase quadratically
 - b) Decrease linearly
 - c) Increase linearly

3. The tipped magnetization vector under the laboratory frame of reference appears,
 - a) Precessing around z-axis at the Larmor frequency
 - b) Stationary
 - c) Rotating at the Larmor frequency.

4. In order to change the slice position of the RF pulse,
 - a) Change the pulse modulation frequency
 - b) Change the slice selection gradient position
 - c) Change the position of the patient

5. In order to change the slice thickness,
 - a) Change the slice amplitude
 - b) Change the envelope at the same bandwidth
 - c) Change the slice selection gradient

6. The rate at which the measured signal in the transverse plan disappears is a function of,
 - a) T_1
 - b) T_2
 - c) $T2^*$

7. The rate at which the inverted magnetization in inversion recovery sequences relaxes depends on,
 - a) T_1
 - b) T_2
 - c) $T2^*$

8. The signal decays fast in free induction decay because of,
 - a) Spin-spin relaxation
 - b) Spin dephasing
 - c) Spin lattice relaxation

9. The signal at time TE in a spin echo pulse sequence depends on,
 - a) T_1
 - b) T_2
 - c) $T2^*$

10. To measure T1, we usually use,
 - a) Inversion recovery pulse sequence
 - b) Gradient echo pulse sequence
 - c) Spin echo pulse sequence

11. The k-space represents,
 - a) The MR image space
 - b) The space where k-space trajectories are designed.
 - c) The Fourier domain of the image

12. The FOV in the read-out direction depends on,
 - a) Sampling bandwidth
 - b) Sampling duration
 - c) Sampling dynamic range

13. The FOV in the phase encoding direction depends mainly on,
 - a) Number of phase encoding steps
 - b) Phase encoding step size
 - c) Matrix size in the phase encoding direction

14. To increase the resolution in the read-out direction at the same FOV, one can,
 - a) Increase the k-space sampling bandwidth in the read-out direction
 - b) Increase the k-space coverage in the read-out direction
 - c) Increase the number of phase encoding steps in the read-out direction

15. To increase the FOV in the read-out direction without affecting the SNR, we can,
 - a) Use the same sampling BW with lower read-out gradient
 - b) Use the same sampling BW with higher read-out gradient
 - c) Use a higher bandwidth with the same read-out gradient

16. Magnetic resonance spectroscopy can be used for,
 - a) Mapping concentration of different metabolites in the human body noninvasively
 - b) Mapping concentration of different nuclei in the human body noninvasively
 - c) Mapping magnetic field inhomogeneity in PPM scale inside the magnet

17. Quenching means,
 - a) The magnet is being turned off after scanning a patient
 - b) The magnet is low on cryogenic agent
 - c) The magnet is abruptly and catastrophically losing magnetic field strength

18. MRA based on TOF can be used to detect,
 - a) Mapping blood velocity inside vessels
 - b) Mapping blood pressure inside vessels
 - c) Mapping vessel anatomy

19. Computed tomography refers to,
 - a) Computing images from their k-space data
 - b) Computing images from their spatial domain information
 - c) Computing sectional images from projection data

20. The problem of SPECT imaging is more difficult because,
- The attenuation as well as the source location are not known
 - The incident x-ray energy is not known
 - The emitted photons are not well-defined in wavelength
21. The image of SPECT is composed of,
- A map of the attenuation of the body
 - A map of the photon source intensity inside the body
 - A map of the positron source intensity inside the body
22. The T1-weighted MR image maps,
- Both spin density and T1 inside the body
 - Only T1 values inside the body
 - Only spin density inside the body
23. The problem of PET reconstruction is solved using,
- Reconstruction from projections
 - Fourier transform
 - Time-delay detector
24. Calculate the cardiac output given the following data: O_2 consumption 200 ml/min, arterial O_2 content 0.2 ml/ml, and venous O_2 content 0.15 ml/ml.
- 3 liters/min
 - 4 liters/min
 - 5 liters/min
25. In the rapid-injection indicator-dilution method,
- The indicator concentration is measured at steady state
 - The indicator concentration curve is measured with time and integrated
 - The indicator concentration is measured right following the rapid injection
26. The thermodilution method relies on,
- Injecting a cold indicator and measuring temperature change to compute flow
 - Measuring flow based on normal body temperature
 - Injecting a dye and measuring its concentration in the blood to compute flow
27. DC flowmeters suffer from,
- Their signal is weak and hardly can be detected
 - Their signal has similar frequency range to that of ECG
 - They cannot measure AC components in the flow signal
28. Plethysmographs measure,
- Change in flow rate
 - Change in heart rate
 - Change in volume
29. Ventricular fibrillation occurs when the current in the patient is in the range,
- Approximately 10-100mA
 - Approximately 100mA-1A.
 - Approximately 1-6A

30. Suitable current range for defibrillators is between,
- 1A-6A
 - 100mA-1A
 - 10mA-100mA
31. Microshock is defined as,
- The situation when a small current induces perception of electricity
 - The situation when an electrical shock is applied from a defibrillator to revive a patient
 - The situation when small currents from invasive devices induce ventricular fibrillation
32. Equipment isolation is usually done using,
- Capacitive or optical isolation barrier
 - Circuit breakers
 - Isolation transformers
33. For a multi-slice imaging sequence with parameters given as: slice thickness: 5mm, flip angle: 60° , matrix size: 256×128 , FOV: $20\text{cm} \times 20\text{cm}$, NEX: 2, and TR/TE: 500/24, the ratio of acquisition time to acquire 25 slices to that of acquiring 20 slices using this sequence is,
- 1.
 - 1.25.
 - 2.
34. A material that is chemically shifted from water by 100ppm has a different resonance frequency at 4T from that of water by approximately,
- 17 kHz.
 - 4 kHz.
 - 6.4 kHz.
35. Shimming coils are used for,
- Protecting the patient from fringe magnetic fields.
 - Implementing the magnetic field gradients.
 - Improving the uniformity of the B_0 field.
36. The total acquisition time for a 3-D Fourier acquisition of a volume of matrix size $128 \times 128 \times 256$ with TR/TE: 100/15ms is approximately,
- 14 minutes.
 - 27 minutes.
 - 54 minutes.
37. For a volumetric acquisition, doubling the number of phase encoding steps in the k_y direction without changing any other acquisition parameters results in,
- Lower SNR by a factor of $\sqrt{2}$.
 - Higher SNR by a factor of $\sqrt{2}$.
 - The same SNR.
38. For MRA based on phase contrast, when a volume of $128 \times 128 \times 128$ is to be acquired in a multi-slice fashion, the minimum number of RF pulses to be used is,
- $128 \times 128 \times 2$.
 - 128×128 .
 - $128 \times 128 / 2$.

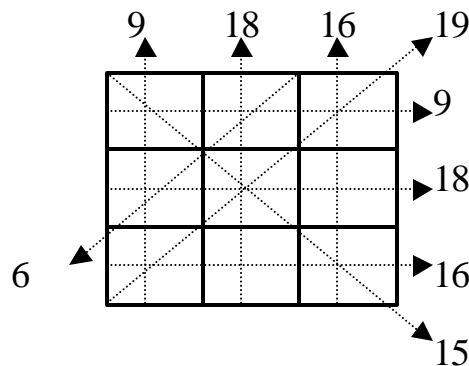
39. In T1-weighted imaging, structures with short T1 appear,
- Darker.
 - Brighter.
 - The same as other structures.
40. In T2-weighted imaging, structures with long T2 appear,
- Darker.
 - Brighter.
 - The same as other structures.

PART II. Answer the following with either True (T) or False (F) (1 point each),

- DSR refers to a method for fast acquisition of SPECT data.
- With 4T magnets, RF pulses are usually modulated with frequencies around 170MHz.
- Acquisition time may vary with both TR and TE.
- The different generations in CT vary in the geometry and numbers of sources and detectors.
- Phase encoding can be theoretically used to encode any number of dimensions.
- Increasing the number of phase encoding steps with the same step size reduces SNR.
- PET relies on detecting and mapping positrons emerging from the object.
- Patient isolation can be done only using isolated power to the equipment and proper Earthing.
- Threshold of perception current denotes the current at which the patient is in danger.
- Fick technique can be used to measure cardiac output.

PART III. Draw a properly labeled fat-nulling magnetic resonance imaging sequence and draw a clear diagram of its k-space trajectory. **(5 points)**

PART IV. Solve the following reconstruction problem using ART **(5 points)**



BEST OF LUCK