

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

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**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:  $60^\circ$ , matrix size:  $256 \times 128$ , 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,
- $128 \times 128 \times 2$ .
  - $128 \times 128$ .
  - $128 \times 128 / 2$ .

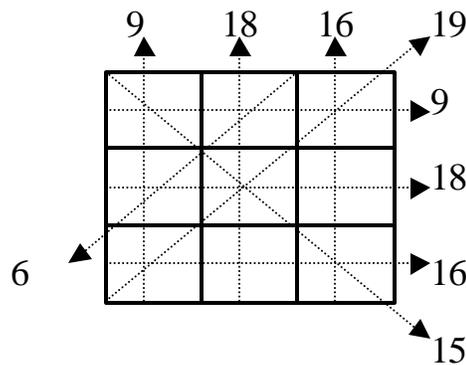
39. In T1-weighted imaging, structures with short T1 appear,
- Darker.
  - Brighter.
  - The same as other structures.
40. In T2-weighted imaging, structures with long T2 appear,
- Darker.
  - Brighter.
  - The same as other structures.

**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**