

MCQ

1. Electric current at the threshold of perception is:
 - a. The minimal current that an individual can detect (*)
 - b. The maximal current that an individual can detect
 - c. The average current that individuals can detect
2. A current of 100 mA flowing through the human body is likely to cause:
 - a. Ventricular fibrillation (*)
 - b. Burns and physical injury
 - c. Sustained myocardial contraction
3. Changing the action of electrosurgical units from cutting to coagulation is done by:
 - a. Changing the envelope, frequency, voltage and power of the applied waveform (*)
 - b. Changing the frequency modulation of the applied signal
 - c. Changing the amplitude value of the applied signal
4. Infant incubators function relies on:
 - a. Temperature control (*)
 - b. Pressure control
 - c. Both temperature and pressure control
5. The necessary requirements for indicators in indicator-dilution methods include being:
 - a. Inert and harmless
 - b. Measurable and always intravascular
 - c. All of the above (*)
6. Possible indicators used in indicator-dilution methods do not include:
 - a. O₂
 - b. Cold saline
 - c. Iodine (*)
7. Transit-time flowmeters rely on
 - a. Time difference between upsteam and downstream transit of ultrasonound (*)
 - b. Doppler frequency shift
 - c. Time of flight effect
8. The most accurate way of measuring changes in blood volume in extremities is using:
 - a. Chamber plethysmography (*)
 - b. Doppler ultrasound
 - c. Indicator-dilution methods
9. Venous-occlusion plethysmography uses:
 - a. One venous-occlusion cuff
 - b. One arterial-occlusion cuff
 - c. One venous and one arterial occlusion cuffs
10. The function of conductivity monitor in hemodialysis is to:
 - a. ensure that the dialysate concentration is appropriate
 - b. ensure that no leakage of dialysate enters into the blood
 - c. measures the ultrafiltration rate
11. Blood leak alarm causes the following to happen:
 - a. Blood pump shutting off (*)
 - b. Dialysate line bypass
 - c. Venous clamp activation
12. Air bubble detection alarm causes the following to happen:
 - a. Blood pump shutting off
 - b. Dialysate line bypass
 - c. Venous clamp activation (*)
13. Removal of water from the body in hemodialysis is done using the following mechanism:
 - a. Diffusion

- b. Perfusion
 - c. Ultrafiltration (*)
14. Doubling the readout sampling period Δk_x results in:
- a. Doubling of FOV in the x-direction
 - b. Halving of FOV in the x-direction (*)
 - c. Doubling of the matrix size N_x
15. Using only half of the phase encoding lines of a given image results in:
- a. Lower resolution in the phase encoding direction
 - b. Lower SNR in the phase encoding direction (*)
 - c. Smaller FOV in the phase encoding direction
16. In order to observe only the arteries while imaging the leg with MRA,
- a. Use a saturation slice above (i.e., closer to the knee) the slice of interest.
 - b. Use a saturation slice below (i.e., closer to the foot) the slice of interest. (*)
 - c. Use MIP
17. If we increase the FOV with the matrix size constant,
- a. Resolution becomes higher
 - b. Scan time becomes lower
 - c. SNR becomes higher (*)
18. In an MRI experiment, a 20 cm \times 20 cm FOV was imaged with a matrix size of 64 \times 64, TR/TE: 2000/30 ms, and flip angle: 60°. To change the matrix size to 64 \times 128, the acquisition time for the new experiment compared to the first will be:
- a. The same (*)
 - b. Double
 - c. Four times
19. An MRI experiment has the following parameters, a 25 cm \times 25 cm FOV was imaged with a matrix size of 256 \times 256, TR/TE: 3000/50 ms, and flip angle: 30°. To decrease the size of the FOV in the phase encoding direction to 25 cm, one must only:
- a. Increase the phase encoding step
 - b. Increase the coverage in the phase encoding direction
 - c. Switch the directions of the readout and phase encoding
20. A T2-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
18. The signal decay in free induction decay is primarily due to,
- a. T1
 - b. T2
 - c. T2*
19. The FOV in the read-out direction depends on,
- a. Sampling dynamic range (ADC bits)
 - b. Sampling bandwidth (*)
 - c. Readout duration
20. To change the slice thickness of an RF pulse, one must do the following:
- a. Change the modulation of the RF pulse
 - b. Change the duration of the RF pulse (*)
 - c. Change the amplitude of the RF pulse
21. In designing an MR facility, portable x-ray equipment should be kept beyond:
- a. 1 Gauss line
 - b. 5 Gauss line
 - c. 10 Gauss line (*)
22. Surface coils are used as high-SNR ...
- a. RF coils (*)

- b. Gradient coils
 - c. Shim coils
23. In order to image the entire spine, we use ...
- a. Extremity coil
 - b. Superconducting coil
 - c. Phased-array coil (*)
24. A patient with a cardiac pacemaker must not come any closer to the magnet than
- a. 5 Gauss line (*)
 - b. 10 Gauss line
 - c. 50 Gauss line
25. Distance to the 5 Gauss line in an MR room is shortest with
- a. Active shielding (*)
 - b. Passive shielding
 - c. No shielding
26. In TOF MRA, flowing blood appears:
- a. Dark
 - b. Bright (*)
 - c. Normal
27. Aliasing artifact in the phase encoding direction results from:
- a. A number of phase encoding steps that is too large
 - b. A phase encoding step that is too large (*)
 - c. Under-sampling the received time-domain echoes
28. To excite the whole volume (i.e., everything inside the magnet) for MR spectroscopy, use ...
- a. Three similar RF pulses in x-, y -, and z-directions with no gradients
 - b. One RF pulse and no gradients (*)
 - c. One RF pulse and equal gradients in x-, y-, and z-directions
29. The Larmor frequency of protons at 10 cm away from the iso-center of a 3 Tesla magnet is:
- a. 128 MHz (*)
 - b. 64 MHz
 - c. 43 MHz
30. Slice selection method of spatial encoding can be applied in ...
- a. 1 dimension
 - b. 2 dimensions
 - c. 3 dimensions
31. Cross-talk is the result of:
- a. Overlapping of adjacent slice profiles (*)
 - b. Overlapping of gradients
 - c. Overlapping of RF pulses
32. To maintain the same resolution in the read-out direction at a larger FOV, one can,
- a. Increase the k-space sampling bandwidth only (*)
 - b. Increase the k-space coverage in the read-out direction only
 - c. Increase both k-space sampling bandwidth and k-space coverage
33. The k-space represents,
- a. The Fourier domain of the image (*)
 - b. The image space
 - c. The wavelet domain of the image
34. The signal at time TE in a spin echo pulse sequence depends on,
- a. T1
 - b. T2 (*)
 - c. T2*
35. Quench situation is when ...
- a. A superconducting magnet becoming resistive

- b. A resistive magnet becoming superconducting
- c. A permanent magnet heats up

Problems

1. The voltage necessary for a DC defibrillator with capacitance of 20 μF to reach 200 J is: ... (sol= 4.472 kV)
2. Based on the Fick technique, calculate the cardiac output given the following data: spirometer O_2 consumption 300 ml/min, arterial O_2 content 0.2 ml/ml, and venous O_2 content 0.15 ml/ml. (sol= 6 L/min)
3. In designing an ultrafiltration rate estimation unit using flowmeters, if the desired accuracy of the ultrafiltration rate calculation is $\pm 5\%$ and given the nominal dialysate flow rate of 1L/min and a desired ultrafiltration rate of 1L/hr, then the accuracy of the flowmeters to be used must be at least: ... (sol= 0.04166%)
4. At 100 keV, if the known attenuation values for a particular tissue type and water are: 0.18 and 0.1707 respectively, then, the CT number of that tissue is: ... (sol= 54.5)
5. The total acquisition time for a TOF MRA 3-D Fourier acquisition of a 20cm \times 20cm \times 15cm volume of matrix size 256 \times 192 \times 64 with TR/TE: 100/15ms and NEX=1 is: ... (sol = 20.48 min)
6. The minimum acquisition time for a multislice acquisition of a 20cm \times 20cm \times 15cm volume of matrix size 64 \times 192 \times 256 with TR/TE: 1000/20ms and NEX=2 is: ... (sol= 12.8 min)
7. Consider the acquisition of a volume at a resolution of 256 \times 256 \times 256 using both multislice and 3D Fourier acquisition methods. The ratio of the SNR of the multislice method to that of the 3D Fourier is given by: (sol = 16)
8. Doubling the matrix size in the phase encoding direction N_y causes the SNR to change by a factor of (sol= 1/sqrt(2))
9. If the difference between the resonance frequencies of water and a particular tissue is 10kHz at 1.5T, then the PPM scale of this difference is: (sol= 156.57 ppm)
10. In designing a rectangular-shaped RF pulse to select a 5 mm slice in a 3T magnet, if the slice selection gradient is set at 5 mT/m and the desired flip angle is $\pi/2$, the RF pulse duration will be ... (sol= 1 ms) and the amplitude will be ... (sol=5.87e-6)

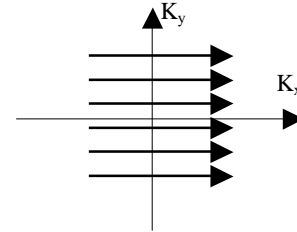
True/False

1. Sustained myocardial contraction results in irreversible damage to heart tissues (F)
2. Infant incubators may use temperature sensors on the infant skin or the surrounding air (T)
3. Transit-time ultrasonic flowmeter is best suited for noninvasive applications (F)
4. Indicator dilution methods are mainly used for measuring cardiac output (T)
5. The presence of venous thrombosis blocking a leg vein causes the leg segment volume to return to normal more slowly after the venous-occlusion cuff is released (T)
6. The acceptable tolerance in dialysate temperature control is 10% (F)
7. The acceptable tolerance in dialysate transmembrane pressure control is 10% (T)
8. Spiral CT can be used to image 3D slabs (T)
9. It is possible to use x, y and z gradients together to produce oblique slices (T)
10. Open MR systems usually utilize superconducting magnets. (F)
11. Linear and computed tomography share the same theory and applications (F)
12. T2-weighted imaging depends on both T2 and proton density distributions (T)
13. The k-space trajectory depends on the flip angle of the RF pulse (F)
14. CT can be used effectively near air or bone tissue interfaces (T)
15. Spiral CT cannot be used to image 3D slabs (F)
16. It is possible to use x and y gradients simultaneously (T)

- 17. Patients wearing analog watches can be allowed into the MR magnet room (F)
- 18. It is possible to indirectly measure the ultrafiltration rate using flowmeters (T)
- 19. MR offers multiple soft tissue contrast unlike other imaging modalities (T)
- 20. MRA can work without injecting a special contrast agent (T)

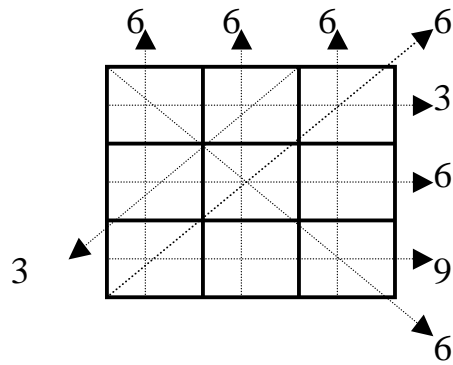
III. Answer the following questions [10 points]:

41. Draw a properly labeled T1-weighted imaging sequence that acquires the shown k-space trajectory of conventional 2D Fourier imaging.



Solution: Standard gradient echo sequence with multiple phase encoding steps (rather than a single one like in the midterm).

Part III: Solve the following CT reconstruction problem using algebraic reconstruction technique



(sol = {1,1,1};{2,2,2},{3,3,3})

Part IV

What is the MR magnet technology that is most suitable for the Egyptian market?