Biomedical Engineering Department *Time Allowed: One Hour*
Cairo University *Open-Book/Open-Notes*

Medical Equipment II Mid-Term Exam – April 2008

Solve as Much as You Can – Maximum Grade: 100 Points

Q1. Answer the following questions by marking the best answer among the choices given (3 points each):

1. For an N×M image, we need to estimate … unknowns.
    a. N^2
    b. M^2
    c. N×M (*)
2. Most medical imaging modalities are designed to not be …
    a. Invasive (*)
    b. Noninvasive
    c. Minimally invasive
3. The earliest medical imaging modality is …
    a. Ultrasound imaging
    b. X-ray imaging (*)
    c. Magnetic resonance imaging
4. In deriving the wave equation in fluids, the following parameter is used …
    a. Young's modulus
    b. Compressibility (*)
    c. Viscosity
5. The following functions satisfies the wave equation …
    a. $F(0.001\,x - 0.2\,t)$ (*)
    b. $F(t\,(x - 100\,t))$
    c. $F(x\,(x - 1000\,t))$
6. Standing waves have …
    a. Locations with zero field regardless of the time (*)
    b. Locations with zero field at periodic time intervals
    c. Locations with peak field magnitude regardless of time.
7. The tissue property used in ultrasound imaging is …
    a. Acoustic attenuation
    b. Acoustic impedance (*)
    c. Acoustic reflection
8. The time for ultrasound to travel through 1 cm of human soft tissues is …
    a. 26 μs
    b. 13 μs
    c. 6.5 μs (*)
9. The attenuation of ultrasound waves in tissues expressed in dB … ultrasound frequency.
    a. Increases linearly with (*)
    b. Decreases linearly with
    c. Does not depend on
10. The appearance of echoes in ultrasound imaging depends on … in the field of view.
    a. The presence of a tissue density mismatch
    b. The presence of acoustic impedance mismatch (*)
    c. The presence of a mismatch in sound speed in tissues

11. Optical coherence tomography is based on …
    a. Acoustic range measurement
    b. Optical range measurement (*)
    c. IR absorption measurement
12. Raman spectroscopy relies on …
    a. Emission of light from atoms with characteristic photon energies
    b. Reflection of light from interfaces
    c. Scattering of light in which scattered photon does not have same original energy (*)
13. Isosbestic point is the point at which …
    a. OxyHb and deoxyHb have the same absorption coefficient (*)
    b. Blood oxygenation level can be directly measured
    c. Blood can be differentiated from water

14. The emissivity of a blackbody is …
    a. 1 (*)
    b. 0
    c. Dependent on λ
15. When a wave moves from one medium to another, its … remains the same.
    a. Frequency (*)
    b. Wavelength
    c. Propagation speed
16. Energy levels can be determined fully by … quantum numbers
    a. 3
    b. 4
    c. 5 (*)
17. Interaction cross section defined …
    a. The probability of that particular interaction taking place (*)
    b. The area in front of the main beam
    c. The area in front of the broad beam including scattering
18. Radiance is used to describe …
    a. Point source
    b. Extended source (*)
    c. Plane wave source
19. Radiation from Lambertian surfaces have …
    a. Equal power per unit area regardless of angle (*)
    b. Anisotropic radiance
    c. Even scattering cross section
20. Each excitation pulse in B-mode ultrasound is used to acquire … of the field of view
    a. One line (*)
    b. One image
    c. One volume

Q2. Mark the following statement as either True (T) or False (F) (1.5 point each):

1. Medical imaging may be used to explore chemical composition of tissues noninvasively (T)
2. It is possible to image physiological functions (T)
3. Static imaging is the future trend of medical imaging (F)
4. High frequency ultrasound offer lower spatial resolution (F)
5. High frequency ultrasound is preferred in imaging situations with small scan depth (T)
6. Ultrasound imaging relies on near field to image soft tissues (F)
7. The radiation energy from a heated atom depends on whether it is in a gas or a solid (T)
8. Objects that appear blackest when absorbing light appear brightest when heated (T)
9. Non-blackbody object has a radiation function that depends on its emissivity as a function of λ (T)
10. No two electrons in an atom can have same values for their quantum numbers (T)
11. The human skin can be well approximated by a blackbody in the visible light spectrum (T)
12. Infant incubator rooms have glass windows to allow sun light to synthesize vitamin D in infants (F)
13. Eye patches should be used when exposing infants to UV therapy for neonatal jaundice (T)
14. UV radiation may damage human DNA (T)
15. Human hearing has a frequency-independent response (F)

Q3. (6 points) Compute the spatial resolution of an ultrasound system with an ultrasound pulse length of 300 ns. (Hint: let spatial resolution be defined as half the spatial length of the pulse)

Q4. (6 points) What is the maximum pulse repetition frequency of an ultrasound system when used to image a field of view of depth 20 cm?

Q5. (10 points) The differential scattering cross section for a beam of x-ray photons from certain material is 50×10^{-30} m^2/sr. A beam of 10^6 photons strikes a target made of this material of thickness 1 cm. Let the density of this material be 2 g/cm^3 and the atomic weight be 12. If the x-ray detector placed 30 cm behind the target is a circle of radius 1 cm, how many scattered photons enter the detector?

Best of Luck!