ELE 588 Biomedical Engineering I Exam #2 Sample Name: _____

Open book/note. Each question is worth 10 points (10 x 10 = 100 points).

1. ( ) Which of the following statements regarding the Technetium 99 ($^{99}Tc^{m}$) in the metastable state is incorrect? (A) $^{99}Tc^{m}$ has a half-life of 6.02 hours. (B) $^{99}Tc^{m}$ is the most frequently used radioactive isotope in nuclear medicine. (C) $^{99}Tc^{m}$ is produced by charged-particle bombardment in a linear accelerator or a cyclotron. (D) $^{99}Tc^{m}$ emits 140-KeV photons. (E) none of the above.

2. ( ) What is the main reason that the spatial resolution of the PET scan (~5 mm) is higher than that of the SPECT (~10 mm)? (A) Detecting two photons traveling in the opposite directions has an inherent advantage for increased spatial resolution. (B) The high energy photons (511 KeV) in the PET system have less a problem with scattering. (C) The higher price of the PET system allows the use of higher precision electronics. (D) The radionuclides used in PET scan, such as ^{68}Ga with a half-life of 68 minutes, have shorter half-lives thereby reducing variability. (E) all of the above.

3. ( ) Assume that the speed of sound in tissue is 1500 m/s. With the pulse repetition rate set at 5 KHz what is the maximum depth of penetration of ultrasound into the tissue? (A) 15 cm, (B) 20 cm, (C) 25 cm, (D) 30 cm, (E) none of the above.

4. ( ) The acoustic impedance is a parameter related to the degree of difficulty for the material to transmit sound waves. The speed of sound in a tissue with a density (ρ) of 1 g/cm^3 is 1.5 x 10^5 cm/s. What is the acoustic impedance of this tissue? (A) 2.25 x 10^5 g•cm^{-2} s^{-1}, (B) 1.75 x 10^5 g•cm^{-2} s^{-1}, (C) 1.5 x 10^5 g•cm^{-2} s^{-1}, (D) 1.22 x 10^5 g•cm^{-2} s^{-1}, (E) none of the above.

5. ( ) We use a 2.5 MHz ultrasound probe to measure the Doppler frequency shift caused by blood flow. The blood is flowing steadily away from the probe at an 45-degree angle. The echoes show a downward frequency shift of 2 KHz. Assume that the speed of sound in tissue/blood is 1500 m/s. What is the velocity of the blood? (A) 0.75 m/s, (B) 0.85 m/s, (C) 1.05 m/s, (D) 1.25 m/s, (E) none of the above.

6. ( ) The B mode display of ultrasound imaging is accomplished by scanning the ultrasound beam over a fan-shaped sector. What technique is employed to scan the ultrasound beam with a linear array of transducers? (A) electronic focusing, (B) pulsed Doppler, (C) synthetic aperture, (D) beam forming, (E) none of the above.

7. ( ) The color Doppler echocardiography shows a narrow jet flow from left atrium to left ventricle during diastole. This jet flow is an indication of the presence of (A) aortic stenosis, (B) aortic regurgitation, (C) mitral stenosis, (D) mitral regurgitation, (E) none of the above.

8. ( ) The color Doppler echocardiography shows a large mosaic region of flows in the left atrium during systole. This observation is an indication of (A) coronary artery disease, (B) mitral prolaps, (C) acute myocardial infarction, (D) congestive heart failure, (E) none of the above.

9. ( ) In nuclear magnetic resonance T1 refers to (A) the time constant of free induction decay, (B) the time constant of molecules to recover from a perturbed position to the equilibrium position, (C) the time between the 90-degree pulse and the 180-degree in a spin-echo sequence, (D) the time constant for dephasing of the molecules, (E) none of the above.

10. ( ) In magnetic resonance imaging how do we distinguish the MR signals from different pixels on the image plane? (A) A magnetic field gradient is applied to the image plane such that signals from different pixels have different frequencies. (B) The MR image is formed by sequentially scanning pixels on the image plane. (C) The MR image is reconstructed by use of either the convolution backprojection method or an algebraic reconstruction technique. (D) Each pixel position on the image plane has a unique combination of the T1 and T2 time constants. (E) none of the above.