

**Part I. Answer these questions by marking the best answer among the choices given: [2 points each]**

1. Ethics and morals differ in that ...
  - a. Only one of them should be followed
  - b. Ethics are for professionals while morals are for non-professionals
  - c. Ethics rules come from the society while morals come from individual beliefs (\*)
  - d. Ethics are the modern version of morals
2. Engineers shall never directly or indirectly ... any contribution to influence the award of a contract.
  - a. Give
  - b. Solicit
  - c. Receive
  - d. Any of the above (\*)
3. Basic idea of ultrasound imaging relies on ...
  - a. Echo ranging (\*)
  - b. Mechanical resonance
  - c. Faster waves than sound
  - d. Longer waves than sound
4. Study of blood flow inside vessels is possible using ... ultrasound imaging.
  - a. A-mode
  - b. B-mode
  - c. M-mode
  - d. Doppler mode (\*)
5. The fundamental approach to the safe use of diagnostic ultrasound is ...
  - a. To use the lowest output power
  - b. To use the shortest scan time
  - c. To acquire the required diagnostic information
  - d. All of the above (\*)
6. If an ultrasound echo returns after  $65 \mu\text{s}$  from its transmission, distance to reflection surface is ...
  - a. 1 cm
  - b. 5 cm (\*)
  - c. 10 cm
  - d. 20 cm
7. Hydrogen nuclei (protons) are most widely used nuclei in MRI because of their ...
  - a. Natural abundance
  - b. Tissue abundance
  - c. Presence in all organic compounds
  - d. All of the above (\*)
8. MRI image is a map for ...
  - a. The wave reflectors inside the body
  - b. The attenuation of tissues in the body
  - c. The distribution of the Hydrogen nuclei in the body (\*)
  - d. The static magnetic field
9. The presence of elevators near MRI systems causes the problem of ...
  - a. Slower elevator motor speed
  - b. Mechanical problems in elevator operation
  - c. Distortion of MRI images (\*)
  - d. All of the above
10. Fluoroscopy is ...
  - a. X-ray imaging for blood vessels
  - b. Projection x-ray imaging
  - c. Digital subtraction x-ray imaging
  - d. Continuous x-ray imaging (\*)

11. During pregnancy, only ... can be used safely.
  - a. X-ray imaging
  - b. Ultrasound imaging (\*)
  - c. MRI
  - d. CT
12. The imaging application that has the highest x-ray exposure dose is ...
  - a. Computed tomography (\*)
  - b. Bone imaging
  - c. Mammography
  - d. Angiography
13. Digital (filmless) x-ray systems have the disadvantage of ... compared to analog (film-based) systems.
  - a. Lower resolution (\*)
  - b. Bad effect on environment
  - c. Processing problems
  - d. Lower contrast that cause problems in viewing
14. In a Hall-Effect sensor, the Hall voltage appears when ... is applied.
  - a. Magnetic field
  - b. Electric current only
  - c. Material properties and electromagnetic field
  - d. Both electric current and magnetic field (\*)
15. The bioelectric signal from surface electrode is ... signal from needle electrode from same location.
  - a. Larger than
  - b. Smaller than (\*)
  - c. Same as
  - d. Opposite in polarity than
16. The measured output of a piezoelectric force transducer is in the form of ...
  - a. Electric charge
  - b. Electric current
  - c. Electric voltage (\*)
  - d. Capacitance
17. The noise in measured bioelectric signals is considered ...
  - a. Periodic
  - b. Not periodic
  - c. Compact support
  - d. Random (\*)
18. For a 60 Hz current passing between two limbs, dangerous effects start from currents more than ...
  - a. 0.5 mA
  - b. 1 mA
  - c. 5 mA (\*)
  - d. 50 mA
19. Fixed (not mobile or portable) equipment should pass ...
  - a. Inward force and impact test (\*)
  - b. Handle test
  - c. Drop test
  - d. Step test
20. To reduce risk of exposure to airborne transmission of disease, it is necessary to use ...
  - a. Respiratory protection (\*)
  - b. Gloves and gown
  - c. Chemical disinfection of hands
  - d. Distance of at least 1m to patients

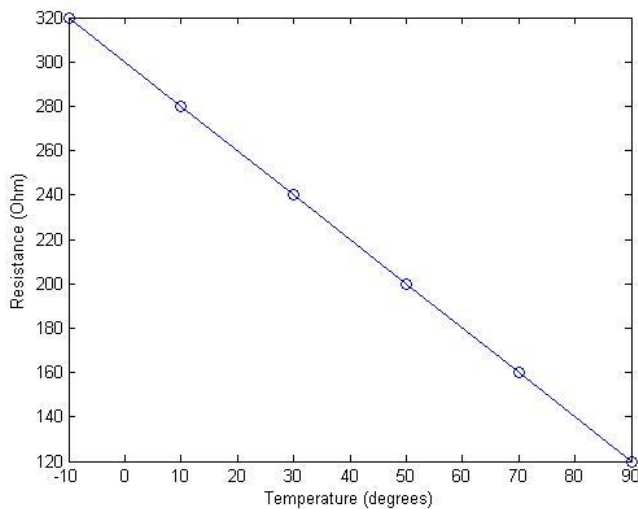
21. The mechanical barriers that prevent germs from penetrating into our bodies include ...
  - a. White blood cells
  - b. Skin (\*)
  - c. Stomach acid
  - d. Hair
22. To reduce risk of exposure to droplet transmission of disease, it is necessary to use ...
  - a. Respiratory protection
  - b. Gloves and gown
  - c. Chemical disinfection of hands
  - d. Nose and mouth protection (\*)
23. Disinfection of surfaces should be done using ...
  - a. Alcohol
  - b. Iodine compounds
  - c. Formaldehyde (\*)
  - d. Physical disinfection
24. The requirements for any infection to develop include ...
  - a. Infectious agent
  - b. Person susceptible to infection
  - c. Contamination that enables colonization of germs on person's body
  - d. All of the above (\*)
25. The disinfection process works by not allowing germs to complete the ... step.
  - a. Germ contamination
  - b. Colonization (\*)
  - c. Deployment of pathogenic properties
  - d. Airborne transmission

**Part II. Mark the following statement as either True (T) or False (F): [1 points each]**

26. Professional ethics guidelines may contradict morals in some cases. (T)
27. Sales engineers are ethically entitled to criticize competitor sales engineers in their company. (F)
28. Sales engineers can criticize technical aspects of products of other suppliers. (T)
29. Engineers should not issue criticism of technical matters if they are paid for by interested parties. (T)
30. According to Kohlberg's theory, moral and technical aspects of engineer development are related. (T)
31. It is possible to pick up interference from EMG when measuring ECG. (T)
32. Piezoelectric transducers are examples of active sensors because they generate voltage. (F)
33. Systematic errors can be reduced by trying same method of measurement several times. (F)
34. Resistance temperature detector (RTD) resistance decreases as measured temperature increases. (F)
35. Physiological artifacts are external signals superimposed on another measured biosignal. (F)
36. Quantization is used to correct for sensor nonlinearity in medical devices. (F)
37. 5 MHz, 10-bit ADC has less sampling errors than 10 MHz, 8-bit ADC. (F)
38. Patient isolation works best when the patient is not connected to the medical device. (F)
39. Blood sugar level signal is an example of a signal that repeats itself. (F)
40. It is possible for a person to suffer a macroshock while an electrical leakage from heart catheter occurs. (F)
41. For environmentally-friendly disinfection, chemical disinfection should be used whenever possible. (T)
42. Ultrasound imaging provide good images for body areas that contain bone or air. (F)
43. X-Ray image is just a map of x-ray reflection in different parts of the body. (F)
44. Film-based x-ray imaging systems allow better viewing of images than digital systems. (F)
45. It is important for doctors to wear protective gear when they are exposed to x-rays. (T)

**Part III. Answer the following question: [6 points each]**

46. Analyze the following situations from the ethical perspective and justify your analysis by pointing out the relevant ethical guidelines:
- A biomedical engineer who uses old or defective spare parts to repair client devices without informing them to quickly finish the repairs while making more money.
  - An engineer who accepts compensation from all suppliers to evaluate their products for potential use in a project for his company.
47. Two pulse oximeter devices gave the following readings taken for the same patients with short interval in between:
- Device #1: 98%, 97%, 96% (mean: 97 , spread: 2)  
 Device #2: 99%, 97%, 95% (mean: 97 , spread: 4)
- If a blood sample was taken from the same patient to a standardized laboratory for testing and the result (considered as true value) was 97%, please answer the following and explain your answer:
- Which of these devices has a better precision?  
**Answer: Device #1**    **Explanation** Spread is 2 while device 2 has spread of 4
  - Which of these two devices has a better accuracy?  
**Answer: Same**    **Explanation:** Mean of readings of both is equal to true value of 97%
48. Consider a temperature sensor with the shown characteristics. Determine the following:
- Sensor offset = intercept at (T=0) = 300
  - Sensor sensitivity = slope = -2 Ohm/degree



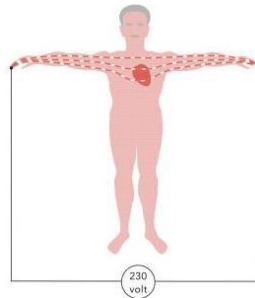
49. In Doppler flowmeter, assuming speed of sound in tissue to be 1540 m/s and an angle of inclination of 45 degree, if an ultrasound imaging systems with frequency 5 MHz is used, what would be the Doppler shift for blood velocity of 0.1 m/s?

$$\Delta f = f_1 - f_2 = f_1 \frac{2v \cos \varphi}{c}$$

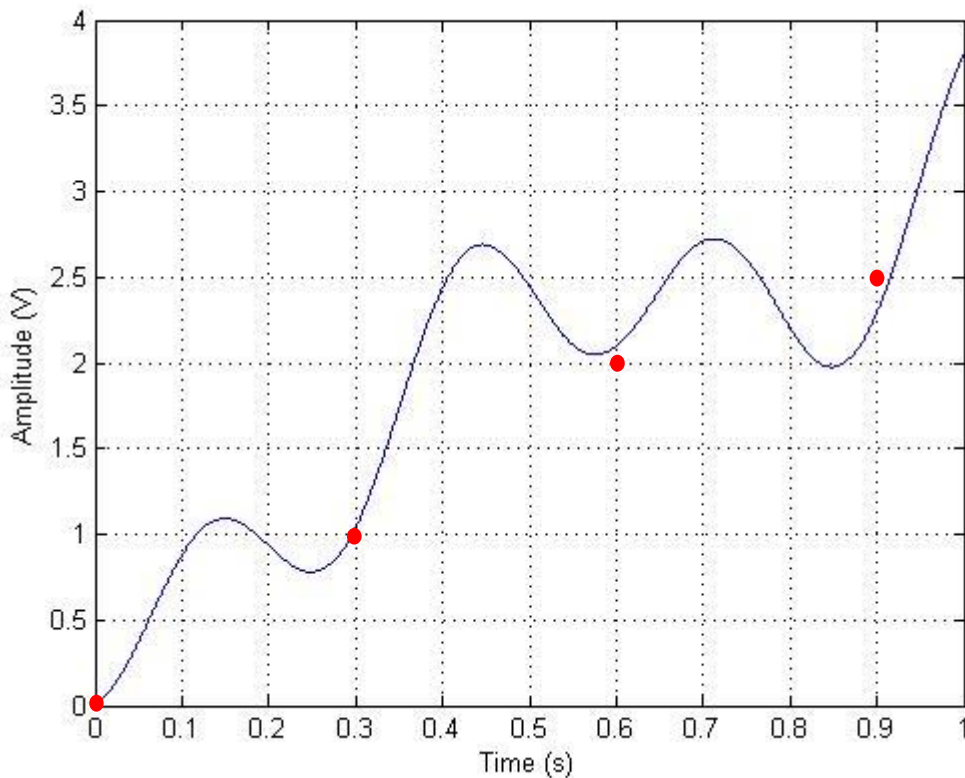
Substitute  $f_1 = 5 \times 10^6$  Hz,  $v = 0.1$  m/s,  $c = 1540$  m/s and angle 45 degrees to calculate Doppler shift

50. Compute the range of currents that could flow through the subject in the situation below assuming that the skin of the subject is intact.

Compute current =  $230V/R$  with both  $R=30K$  and  $R= 2M$



51. For the signal shown below, if it is sampled with a sampling period of 0.3 s and quantized with a step of 0.5 V, draw the resultant digital signal. Comment on the similarity between the original analog and output digital signals.



Comment: Analog and digital signals look very different. Insufficient sampling seems to be the main reason for this difference.