

Part I. Answer these questions by marking the best answer among the choices given: [5 points each]

1. A biosensor that changes its resistance depending on measured temperature is considered ...
 - a. Active (*)
 - b. Passive
 - c. Primary
 - d. Secondary
2. ECG measurement is not likely to have interference from ...
 - a. EMG (Muscle)
 - b. EUG (Uterus)
 - c. EGG (Stomach) (*)
 - d. Nearby electromagnetic fields
3. Biosignal artifacts may not be caused by ...
 - a. Interference from external sources
 - b. Applied measurement methodology
 - c. Biosignal shape and frequency (*)
 - d. Patient
4. Within the sensor dynamic range, the sensor is expected to ...
 - a. Behave linearly
 - b. Have more sensitivity
 - c. Have more precision
 - d. Measure accurately (*)
5. The primary signal for a thermocouple biosensor is ...
 - a. Voltage (*)
 - b. Resistance
 - c. Temperature
 - d. Capacitance
6. Gradual change in the measurement output while the measurand remains constant is called ...
 - a. Sensor offset
 - b. Sensor reproducibility
 - c. Sensor drift (*)
 - d. Sensor Hysteresis
7. The unique aspects of measuring in medicine include ...
 - a. Nonlinearity of sensors
 - b. Wide variations with inter/intra-individual deviations (*)
 - c. Low accuracy of sensors
 - d. Using chemical and optical methods in addition to electrical methods
8. In a Hall-Effect sensor, the Hall voltage is proportional to ...
 - a. Magnetic field only
 - b. Electric current only
 - c. Material properties and electromagnetic field
 - d. Both electric current and magnetic field (*)
9. To design a low cost system for measuring temperature within human temperature range while maintaining highest sensor sensitivity, ... is preferred.
 - a. Platinum RTD
 - b. Thermistor (*)
 - c. Thermocouple
 - d. Temperature IC

10. The bioelectric signal from surface electrode is ... signal from needle electrode from same location.
- Larger than
 - Smaller than (*)
 - Same as
 - Opposite in polarity than

Part II. Mark the following statement as either True (T) or False (F): [3 points each]

- Thermocouple is an absolute sensor. (F)
- It is possible to pick up interference from blood pressure signal when measuring pulse rate. (F)
- Oxygen saturation is considered as a bio-optical signal. (T)
- Piezoelectric transducers are examples of passive sensors. (T)
- Sensor response time is different from its recovery time for nonlinear sensors. (F)
- Systematic errors can be avoided by designing different method of measurement. (T)
- Resistance temperature detector (RTD) change linearly with measured temperature. (T)
- 8-bit sensors will have better resolution than 10-bit sensors. (F)
- Physiological artifacts are biological signals superimposed on another measured biosignal. (T)
- Precision refers to difference between true value and actual value measured by biosensor. (F)

Part III. Answer the following questions: [10 points each situation]

21. Two pulse oximeter devices gave the following readings taken for the same patients with short interval in between:

Device #1: 99%, 96%, 94%

(mean: 96.3333 , spread: 5)

Device #2: 96%, 97%, 95%

(mean: 96 , spread: 2)

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:

- a. Which of these devices has a better precision?

Answer: Device #2 **Explanation** Spread is 2 while device 1 has spread of 5

- b. Which of these two devices has a better accuracy?

Answer: Device #1 **Explanation:** Mean of readings of device 1 is closer to true value of 97% than device 2 (device #1 error is -0.6667% while device #2 error is -1%)

22. Consider a temperature sensor with the shown characteristics. Determine the following:

- Sensor offset = intercept = 1000
- Sensor sensitivity = slope = -100 Ohm/degree

