

Study Guide for Quiz 3

The third quiz will consist of problems based on material from the lectures and HWs, similar to the first two quizzes. The material covers topics in lecture from Week 6 up to Week 8. This quiz will also be on-line, open-book, and open-notes.

Topics covered and specific items to review (see Webster, 4th Ed.):

Biopotential amplifiers and signal processing [Ch. 6]:

- a. Electrocardiogram [Sec. 6.2]: Current dipole, and cardiac vector. Electrode placement, and leads. Vectorial interpretation of ECG signals as inner product between cardiac vector and lead vector. 10-electrode, 12-lead ECG. Wilson central terminal. Frontal plane and transversal plane leads.
- b. Interference and common mode rejection [Sec. 6.3]: Sources of interference. Common mode interference noise rejection. Common mode rejection ratio (CMRR, see also Ch. 3). Grounding of the body, and the effect of electrode impedance mismatch and input impedance on common mode interference noise (Fig. 6.11).
- c. Input and transient protection [Sec. 6.4]: diode protection.
- d. Common-mode and interference reduction circuits [Sec. 6.5]: Driven-right-leg system.

Blood pressure [Ch. 7], blood volume and blood flow [Ch. 8]:

- e. General concepts of blood pressure, volume and flow measurement techniques [Sec. 7.1-7.4, Sec. 7.13-7.14, Sec. 8.1-8.4].
- f. Simplified analogous electrical circuit (Fig. 7.8(c)) and corresponding dynamic pressure response [Sec. 7.3]. No need to memorize second-order equations but need to be able to derive R, L, and C, and find natural frequency and damping ratio when the transfer function is given.
- g. Doppler frequency shift for ultrasonic blood velocity measurement.

Chemical biosensors [Ch. 10]:

- h. Blood-gas and acid-base physiology [Sec. 10.1]: pH, PO₂ and SO₂, PCO₂.
- i. Electrochemical sensors [Sec. 10.2]: pH Nernst cell, pO₂ Clark electrode, PCO₂ electrode. When reactions and the relevant parameters are given, use these to find pH, PO₂, or PCO₂.
- j. Ion-sensitive [Sec. 10.4] and immunologically sensitive [Sec. 10.5] field-effect transistors.
- k. Chemical fibrosensors [Sec. 10.3], and non-invasive optical techniques [Sec 10.6]. When Beer's law is given, use it with relative absorptivities and concentrations of HbO₂ and Hb.

If you are asked to 'sketch' the value of a voltage or current, this would mean make a graph with axis scales, typically as a function of time (unless directed otherwise). If the questions just says to "find" a voltage or current or other quantity, that would mean to derive an equation or numerical value for the variable in question.