Introduction to Biomedical Engineering: Spring 2021

Homework 4

Due: **6/3 PM 1:10**

As usual, please submit your homework in .doc/.docx format to me (*chuang@mail.ee.nsysu.edu.tw*) before deadline. The file name should appear as "your student ID"-hw4. For example: B049011099-hw4.doc.

1. As rapid development of wearable devices in recent years, some manufacturers claimed that their new products, such as ASUS VivoWatch or Samsung Galaxy Watch Active, not only can be used to monitor heart rate, but also are available for measuring blood pressure. Although more and more wearable devices that are capable of similar functions are released, explanation on how blood pressure is measured without a cuff on the upper arm or wrist and its accuracy is seldom provided. Please search for at least one scientific report, either journal article or thesis (中英文皆可), related to blood pressure measurement using wearable devices and introduce its principle to me (中英文皆可). Then imagine that you are explaining in a simpler way to your friend whose major is not Biomedical Engineering. (限中文 200 字以內)
   Note: The technology applied in wearable devices may differ from each other. The key point is to report how blood pressure is measured with the wearable device(s) that was used in the scientific reference, instead of the purpose or conclusion of the reference itself.

2. Given the table of absorptivities (or extinction coefficients in class, in unit of L/mmol/cm) of hemoglobin as below, please plot the relationship (using Excel, MATLAB, or other mathematic programming software) between the arterial oxygen saturation level (SaO_2, 0%~100%) versus the ratio of the red light and infrared light absorbance (A_R/A_{IR}). Assume that only two types of hemoglobin, oxyhemoglobin (HbO_2) and deoxyhemoglobin (Hb), are contained in the blood. Note that the absorbance (A_λ) at specified wavelength (λ) is defined by the Beer–Lambert law as:

$$A_\lambda = -\log\frac{I(\lambda)}{I_0(\lambda)} = \varepsilon cL$$

   where I: the intensity of light at a specified wavelength λ that has passed through a sample,
   I_0: the intensity of incident light,
   c: the molar concentration (mol/L or mmol/L) of the substance(s) that absorbs light,
   L: light path length in cm,
   ε: molar absorptivity.

Absorptivity (ε , L/mmol/cm)	Red light (660 nm)	Infrared (805 nm)
HbO2 (oxyhemoglobin)	0.08	0.20
Hb (deoxyhemoglobin)	0.81	0.20

   Hint: By assuming the concentration of hemoglobin (C_{Hb}) in the blood, the concentration of oxy- and deoxyhemoglobin can be represented as C_{Hb}*SaO_2 and C_{Hb}*(1-SaO_2), respectively.