Practice Multiple choice questions:
The answers are given at the last page (p4)

Q1. Four important types of filters are: low-pass filters, high-pass filters, band-pass filters and band-stop filters. Which of the following options is correct?
a. A band-pass filter can be made by combining a low-pass filter and a high-pass filter.
b. A band-stop filter can be made by combining a low-pass filter and a high-pass filter.
c. A low-pass filter can be made by combining a band-pass filter and a band-stop filter.
d. A high-pass filter can be made by combining a band-pass filter and a band-stop filter.

Q2. A lowpass-filter with a cutoff frequency of 10 Hz has an amplitude ratio of 0.1 at 100 Hz, and an amplitude ratio of 0.01 at 316 Hz. What is the slope of the line in the Bode magnitude plot of this filter for frequencies abetween 100 and 316 Hz?
a. $-4.2*10^{-4}$ dB/octave
b. -0.60 dB/octave
c. -12 dB/octave
d. -40 dB/octave

Q3. John measures a signal. The interesting part of the signal contains frequencies between 10 and 50 Hz. The signal also contains noise with frequencies up to 700 Hz. He uses a suitable anti-aliasing filter. He is interested in the amplitude of the signal. What is a suitable sampling rate to investigate the signals amplitude?
a. Sampling rate: 105 Hz
b. Sampling rate: 255 Hz
c. Sampling rate: 1500 Hz
d. Sampling rate: 3600 Hz

Q4. Stijn measured his speed during a bicycle ride with a sampling rate of 10 Hz. The reliability of the device he used to measure his speed is low. Stijn wants to use the measured speed to calculate the acceleration and cycled distance for every point in time for which he measured the speed. For which derivation(s) is lowpass-filtering the data really needed in order to get reliable results? (Really needed means, filtering makes a large difference.)
a. Filtering is not needed for both derivations.
b. Filtering is needed to determine the acceleration but not to determine the cycled distance.
c. Filtering is needed to determine the cycled distance but not to determine the acceleration.
d. For both derivations filtering is needed.

Q5. Marianne can choose between two systems: an Optotrak and a Vicon system. She wants to know how participants move the tip of each finger of the left hand during a certain task. Therefore, she uses five markers. During the task the

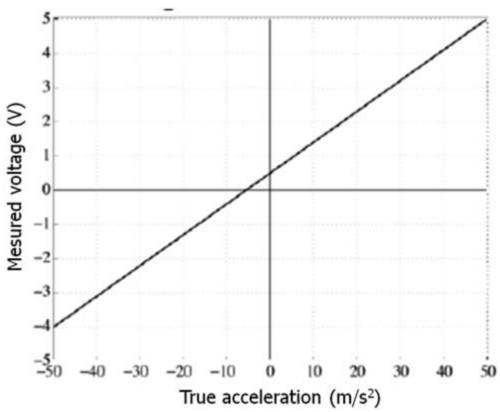
participants make complicated hand movements and they get online feedback about the positions of their fingers. Which system is best to use?
a. Optotrak, because with Optotrak there is less chance of detecting infrared radiation which is reflected by a reflective surface.
b. Optotrak, because with Optotrak the markers cannot be misidentified.
c. Vicon, because with Vicon the chance of markers moving out of the measurement volume is smaller.
d. Vicon, because with Vicon the sampling rate can be higher.

Q6. In which of the following situations is it wise to rectify the EMG signal?
a. You want to determine the PSD of an EMG signal during maximal voluntary contraction.
b. You want to determine the median frequency of an EMG signal of a fatigued muscle.
c. You want to determine the course of the muscle activity as a function of time from an EMG signal during a constant force task.
d. You want to determine the effective value (RMS-value) of an EMG signal measured during a task in which the subject produced a periodic force with a contraction frequency of 0.5 Hz.

Q7. John throws a ball into the air and measures the vertical speed at the moment the ball leaves the hand. He measures a speed of 32.6 km/h with a standard error of the mean of 0.4 km/h. He uses the speed to determine the highest point the ball reached using: $h = \frac{1}{2}v^2/g$. With h the highest point in m, v the speed of the ball at the start in m/s ,and g = 9.81 m/s^2 (acceleration due to gravity). He finds $h = 4.1796$ m. What is the corresponding standard error of the mean?
a. 0.05 m
b. 0.10 m
c. 0.4 m
d. 1.3 m

Q8. Why is a triaxial accelerometer often combined with a triaxial gyroscope?
a. Because with only a triaxial accelerometer you cannot discern between translation, gravitation and rotation.
b. Because a gyroscope adds information on the direction in which you translate.
c. Because a triaxial accelerometer could suffer from drift.
d. Because the reliability of triaxial accelerometers is low.

Q9. The figure below shows a measured input-output plot of an accelerometer. What are the sensitivity and the offset of this accelerometer?



a. Sensitivity: 0.09 Vs^2/m, offset: 0.5 V
b. Sensitivity: 0.5 V, offset: 0.09 Vs^2/m
c. Sensitivity: 0.09 Vs^2/m, offset: -4 V
d. Sensitivity: [-4,5]V, offset: 0.5 V

Answers:

Q1: a, (you can know this by sketching the bode magnitude plots of the filters).

Q2: c, number of dB=-20 dB, number of octaves=1.66, slope=-20/1.66=-12 dB/octave.

Q3: b, Sampling rate 255 Hz (see syllabus page 46),

Q4: b, Filtering is needed for the acceleration, because acceleration is the derivative of the speed, which is sensitive to random errors. Filtering is not really needed for the cycled distance because the sum of the values is not sensitive for random errors.

Q5: b, having no problem with marker identification is important because of the online feedback and the complicated hand movements.

Q6: c, Rectification can be used to visualize the EMG amplitude. Rectification is not necessary for the effective value, since this entails taking a square root of the signal.

Q7: b, The general equation for error propagation is $\Delta v = \left|\left(\frac{dv}{dt}\right)\right| \Delta t$. In this case v = h and t = v, and the derivative $\frac{dv}{dt}$ is $\frac{v}{g}$. Filling this in in the formula gives $\Delta h = 0.10$ m

Q8: a, With the accelerometer you also measure gravitational acceleration. This is difficult to separate from the linear acceleration without using a gyroscope.

Q9: a, Offset = the value when it should be 0, sensitivity = the slope of the line.