Exercise: Session 9

Exercise 1

An AC electromagnetic flowmeter is powered by a trapezoidal signal as indicated in Fig. 1 below.

1) Plot the induced voltage and the measured signal corresponding to the blood flow. Assume any continuous function (with respect to time) for the instantaneous blood velocity or simply use the curve shown on slide 31 in Chapter Inductive sensors.
2) Indicate on the graph the best time for sampling the signal.

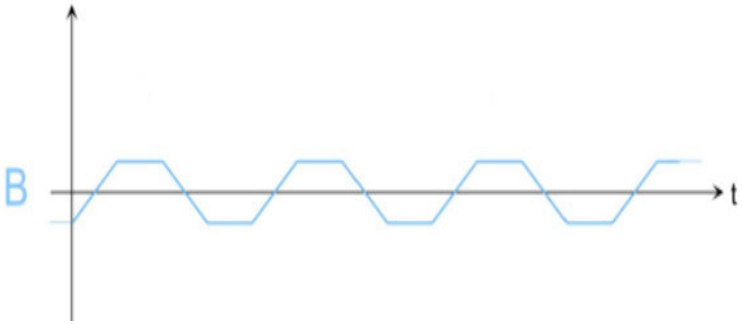

Figure 1: Trapezoidal signal used to power the AC electromagnetic flowmeter

Exercise 2

We plan to use an LVDT (Linear Variable Differential Transformer) driven by an oscillator at 3 kHz to experimentally analyze the non-linear relationship between the lengthening of a sheep ligament and the applied force. The experimental setup is as shown in Fig. 2

1) Preliminary question: is the elastic modulus of the ligament greater or smaller when the force is higher? Justify your answer. Explain how the elastic modulus can be experimentally estimated from the setup shown in Fig. 2.
2) Represent the circuit of a simple demodulator with a single diode placed at the output of the LVDT.
3) Calculate the value of the resistance and capacitance (i.e. give the values of one plausible resistance-capacitance combination) in the simple diode demodulator circuit necessary to remove the oscillations due to the oscillator in order to measure the deformation of the ligament in a dynamic test at less than 10 Hz.
4) What are the limitations of this simple demodulator compared to a synchronous detection?

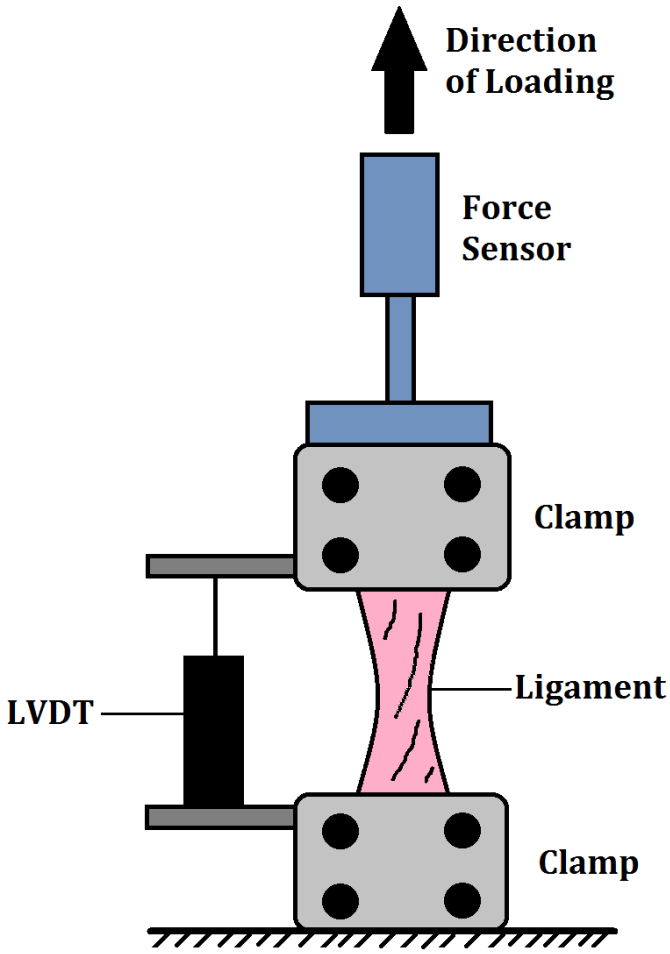
Direction
of Loading
Force
Sensor
Clamp
Ligament
LVDT
Clamp

Figure 2