Assignment 3
A Study of An Experimental SDOF System II

Purpose:	An experimental structure that can be approximated as single-degree-of freedom system will be studied. Spectral Densities and Transfer functions will be calculated from random data.
Preparation:	Study chapter 5 and chapter 7 in '**Introductory Noise and Vibration Analysis**'.
Equipment:	Cantilever Beam Accelerometer and cable Force Transducer and cable National Instrument device, NI USB-9162 Shaker, Stinger, Signal Generator & Amplifier
Software:	Matlab
Computer (Windows)	A Laptop is provided in the Lab. However, you are welcome to use your own Laptop. You require National instruments drivers (NIDAQ960f0) and Data Acquisition tool box in Matlab.
Latest Submission date:	**T.B.D**

Problem Description

A simple dynamic systems which can be estimated as a single-degree-of-freedom (SDOF) system will be studied. The testrig consist of a mass connected at the end of a beam as shown in Figure 1.

Figure 1. *The studied system*

We will assume that the vibrations are small and that the dynamic behaviour in this mechanical system can be sufficiently described with a SDOF model as shown in Figure 2.

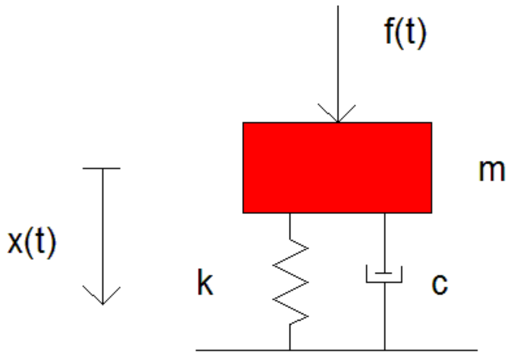

Figure 2. *A single-degree-of freedom system*

The equations of motions for this system can be written as:

$$\mathbf{m} \cdot \ddot{\mathbf{x}}(\mathbf{t}) + \mathbf{c} \cdot \dot{\mathbf{x}}(\mathbf{t}) + \mathbf{k} \cdot \mathbf{x}(\mathbf{t}) = \mathbf{f}(\mathbf{t}) \qquad (1)$$

Your task is to measure the force and the acceleration under random excitation. Frequency response functions and other quantities will then be calculated.

Experimental Work

Mount the shaker, the force transducer and the accelerometer as shown in Figure 3.

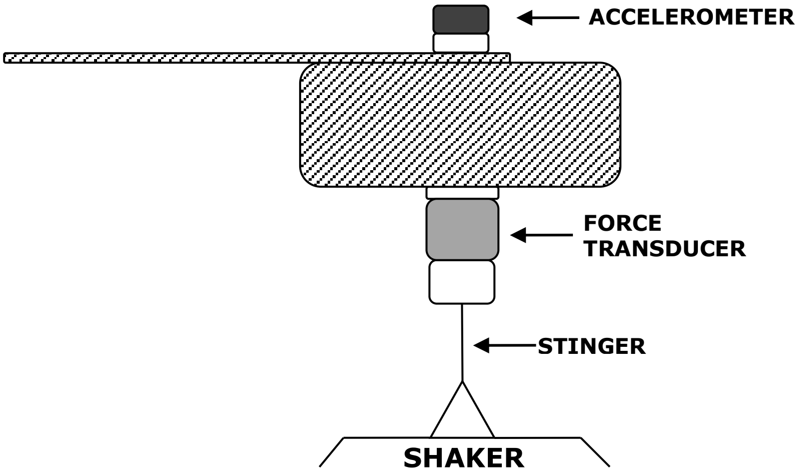

Figure 4. *The experimental setup*

Use the Signal Generator to create a white excitation signal ("Noise") which is then sent to the amplifier. Make sure that the amplifier is set to zero before you turn on the signal generator. Then increase the amplification slowly (the vibration level on the mass should be so small that you can barely feel it with your finger).

The force and the acceleration are measured with the National Instrument device shown in Figure 5. First, connect your acceleration cable to the data acquisition unit, **channel Ai0**. Then connect the force cable to **channel Ai1**. Plug in the USB-unit to the computer and start MATLAB.

Figure 5. *The data acquisition unit*

To acquire data in MATLAB, use the "matlab_help.pdf" document available in the Labs folder on "itslearning".
Use sampling frequency **Fs = 4000 Hz** and select a proper **N.** The measurement time is given by **T=N/Fs** seconds.

Measure the force and the acceleration (simultaneously) for at least 120 seconds. Then create a time vector for your signals and save the data.

Check and document the sensitivity on the force transducer and the accelerometer as you will use this to convert your voltage signals to force/acceleration.

The weight of the mass connected to the beam = ***will be given in the Lab***.

Matlab Work

Task 1. Experimental Data.
Use the sensitivity to calculate the force [N] and the acceleration [m/s^2] from your voltage signals. Plot the acceleration (m/s^2) and the force (N) in the time domain.

Task 2. APDF
Calculate an amplitude probability density function for the force signal and the acceleration signal (two graphs). In each case, plot the result together with a theoretical normal distribution.

Task 3. Auto Spectral Densities
Calculate the PSD of force signal and the PSD of the acceleration signal. Use 50% overlap and a hanning window. Select a suitable blocksize - the frequency increment should (preferably) not be larger than df=0.2 Hz. Produce two figures; one for the force PSD and one for the acceleration PSD. Show the result between 5 Hz to 500 Hz.

Task 4. Cross Spectral Densities
Calculate the CSD between the acceleration signal and the force signal. Use 50% overlap and a hanning window and the same blocksize as you used in Task 2. Plot the result in a figure between 5 Hz to 500 Hz. How would you interpret the CSD?

Task 5. Frequency Response Functions
Calculate the frequency response function between force and acceleration using first the H_1-estimator and then the H_2-estimator. Plot them together in a figure and comment on the result. The frequency range in your figure should be 5-500 Hz.

Task 6. Coherence Functions
Calculate the coherence function and plot it in a figure in the frequency range 5-500 Hz. How would you interpret the result?

Task 7. Comparison
Compare the frequency response functions you calculated in Task 5 with the transfer function obtained in Assignment 1 (Impulse Hammer Test). Comment on the difference.

Report

A short and well written technical report shall be produced. **Use the Template at the homepage.**

Submission

Use It's Learning to submit your report. Go to folder Assignment 2011/Submission. Then click on 'A3 submission' and upload your report (before the deadline).

Good luck!