Modelling and control summaries

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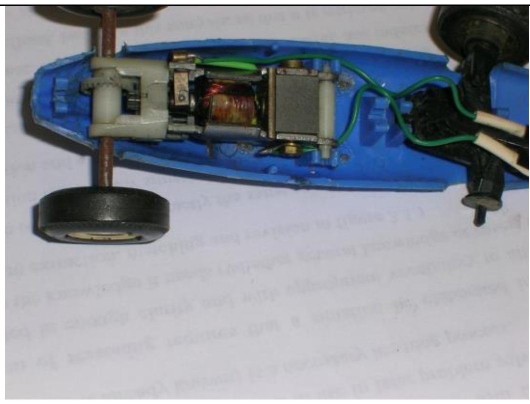
MATLAB GUIs – Modelling a DC servo

ASSUMPTION: Students should understand how to derive a simplified model of DC servo. See section on 2nd order modelling for more detail.

$$v = \frac{\mathrm{J}k}{\mathrm{K}}\frac{d^2 w_L}{dt^2} + \left\{\frac{\mathrm{B}k}{\mathrm{K}} + \frac{JR}{k}\right\}\frac{dw_L}{dt} + \left\{k + \frac{BR}{k}\right\}w_L$$

J is inertia of load
B is damping of load
k is the constant linking back emf and rotational frequency.
R is the resistance in the coil.
K represents any springiness in the shaft – here assume K=∞ so model simplifies to:

$$v = \left\{\frac{JR}{k}\right\}\frac{dw_L}{dt} + \left\{k + \frac{BR}{k}\right\}w_L$$



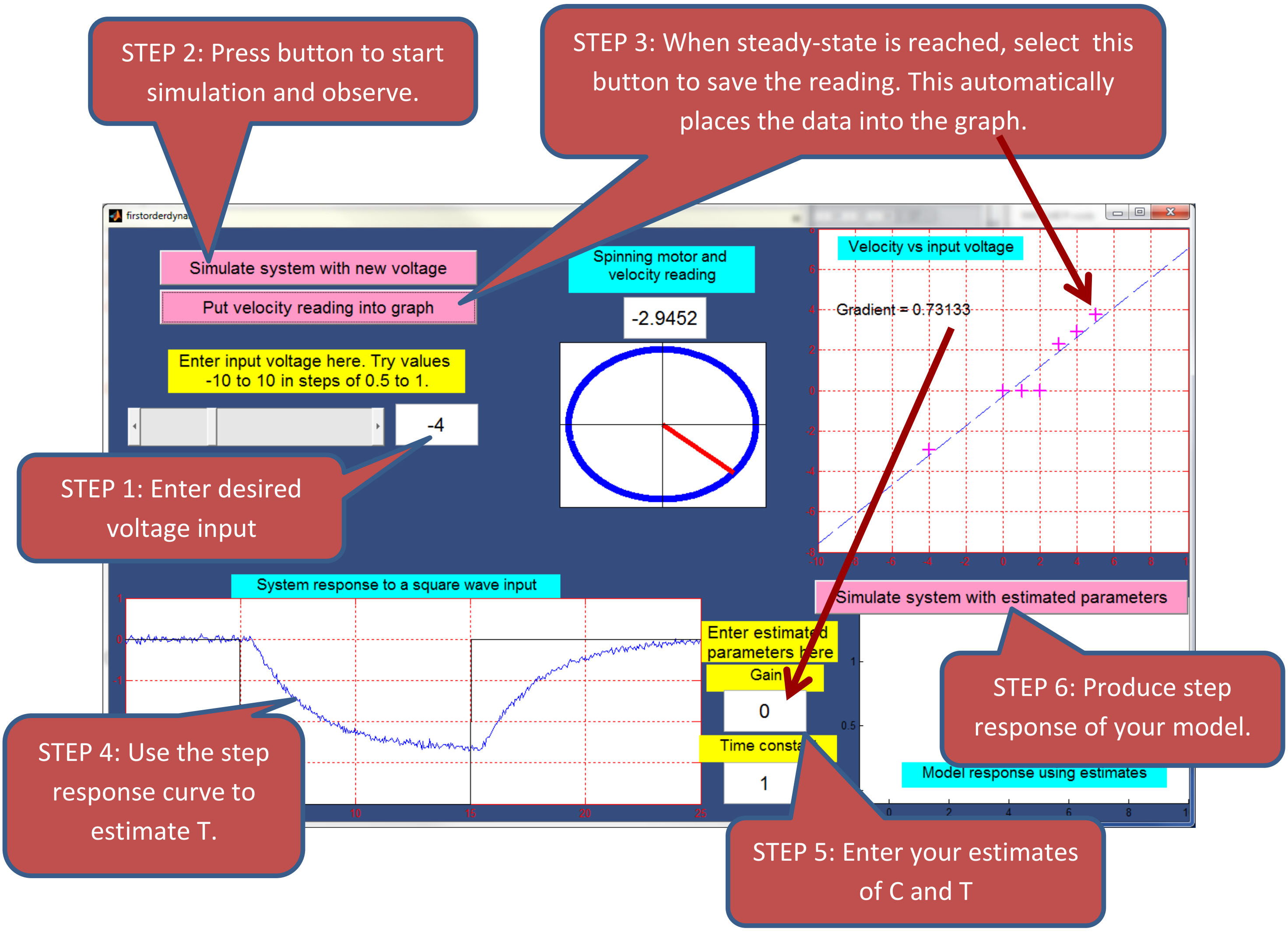
SUMMARY: The model between angular velocity of the load and voltage supply to a simple DC servo can be well represented by a 1st order ODE.
First order models can be represented in time constant form with parameters of gain (C) and time constant (T) as:

$$Cv = T\frac{dw_L}{dt} + w_L$$

The MATLAB GUI is use to represent an experimental technique for determining the parameters C and T

Estimating C using measured data.	• In steady-state one has the relationship $Cv=w_L$ • Plot a graph of v against w_L for a number of different values. The gradient of the curve will be C.
Estimating T using measured data	Readers are referred to the section on 1st order responses where it is shown that for a standard step response, the curve reaches 63% of the steady-value in T sec.

Operation of the GUI is described below. Users should recognise that, as with taking real experimental data, the user is required to perform operations in a well defined sequence in order to collect the correct results. Failure to use this sequence can give poor results.



USERS should **repeat steps 1 to 3** for a wide range of voltages in order to get a large scale view of the velocity dependence upon voltage and whether this is in deed presented by a straight line. [**WARNING**: when 1st opened it can take a while for the 1st value to run as MATLAB is opening relevant files/toolboxes so please be patient before moving to the 2nd value of voltage].

Notes:

- Once sufficient points are on the graph, the GUI will provide an estimate of C (gradient) for you.
- Real systems tend to include stiction. You will note that there is no movement/velocity for low voltages as the torque is too small.

ILLUSTRATIONS – users will see the motor spinning at different speeds as he voltage is changed, but only after selecting 'simulate with new voltage' button.

FILENAMES are firstorderdynamics.p, firstorderdynamics.fig and nonlinear1stordermodel.mdl
All 3 are needed!
Type >> firstorderdynamics to run