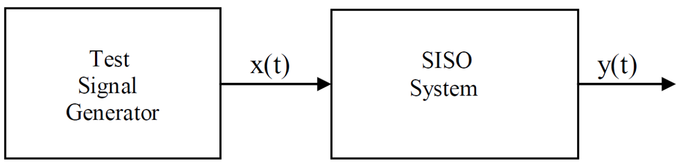
Jadavpur University
Department of Instrumentation and Electronics Engineering
Control Systems Laboratory

Experiment no. 2

Identification of A Linear System from Step Response Test

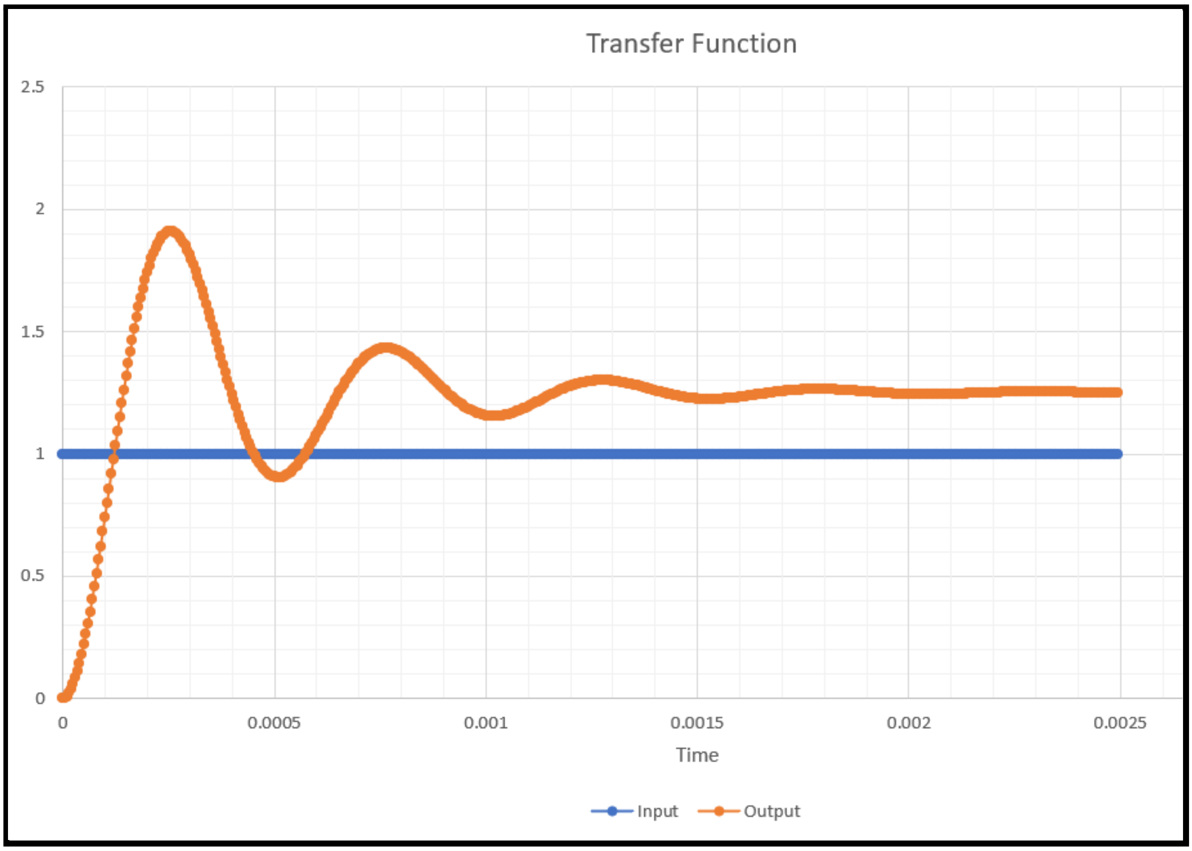
Objective: To identify the second-order model of a simple linear system from its step response.

Theory:
The system is a linear, single-input-single-output (SISO) one that produces a damped oscillatory response corresponding to a voltage step input. Instead of using a voltage step function as input, a unipolar rectangular pulse signal is used so that observation of the time domain response in an oscilloscope becomes easy. The output high and low duration of the input pulses are so chosen that each is greater than the settling time of the system. The system block diagram of the test setup may be of an order higher than 2nd, but a 2nd-order model of the system can be identified from the step response by observing some important characteristics of the response.



Block diagram of the test setup

Plotting the data given in TR_data.csv - TR_data.csv , graph obtained :-



- The steady-state value of response, Yss = 1.249679
- Rise time, tr = 0.9997432 sec
- Amplitude of the first peak, Yp1 = 1.908274
- Time corresponding to peak, tp1= 0.000255 sec
- Amplitude corresponding to the first undershoot, Yt1 = 0.903341
- Amplitude of the second peak, Yp2 = 1.432556
- Time corresponding to second peak, tp2 = 0.000765 sec
- DC gain of the system, K (=Yss/ Ax) = 1.249679
- Peak percentage overshoot Mp1 = 52.701134 %
- Damping factor of the system, z = 0.1997779
- Damped angular frequency of oscillation, wd = 12319.9712 rad/sec
- Natural frequency of oscillation, wn = 12573.4365 rad/sec

Hence, transfer function of the system in the standardized 2nd-order form :-

T(s) = K*wn^2/(s^2+2*z*wn*s+wn^2)

- Attenuation ratio defined as = (Yp2 -Yss)/ (Yp1-Yss) =0.27768