Experiment Three

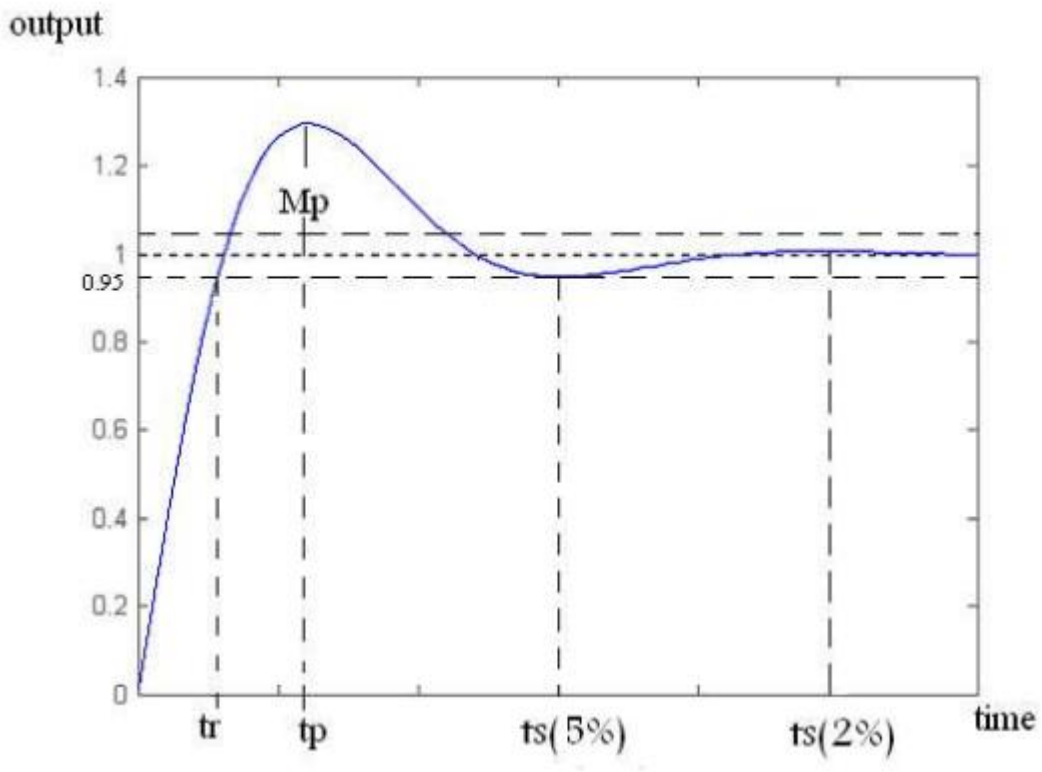
Second Order Systems Analysis

Object:

To study the characteristics of time response of second order control system.

Theory:

The transient response to unit step for a second order control system can be represented in figure (3-1).



Fig(3-1): second order transient response

Transient response terms are as follows:

tr = rise time (the time to reach 0-100 %, 5-95 % and 10-90 % of the input signal).

tp = peak time (the time to reach the maximum overshoot).

Mp = maximum overshoot.

ts = settling time (the time to reach of steady state error).

We can find the system parameters by the equations:

$$Mp = e^{-\xi \ \Pi / \sqrt{1-\xi^2}}, tp = \Pi / \omega_d$$

$$ts = \frac{3}{\xi \ \omega_n} \qquad for \ \ 5\% \ \ E_{s-s}$$

$$ts = \frac{4}{\xi \omega_n} \qquad for \ \ 2\% \ \ E_{s-s}$$

$\omega_d = damping\ of\ natural\ frequency\cdot$

$\omega_n = natural\ frequency\cdot$

$\xi = damping\ ratio\cdot$

The equation becomes:

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1 + G(s)\ H(s)}$$

$$G(s) = \frac{\omega_n^{\,2}}{s^2 + 2\xi\omega_n s}$$

$$\mathrm{H}(s) = 1$$

$$\frac{C(s)}{R(s)} = \frac{\omega_n^{\,2}}{s^2 + 2\ \xi\ \omega_n s + \omega_n^{\,2}}$$

By using Matlab and Simulink the block diagram representation can take the form:

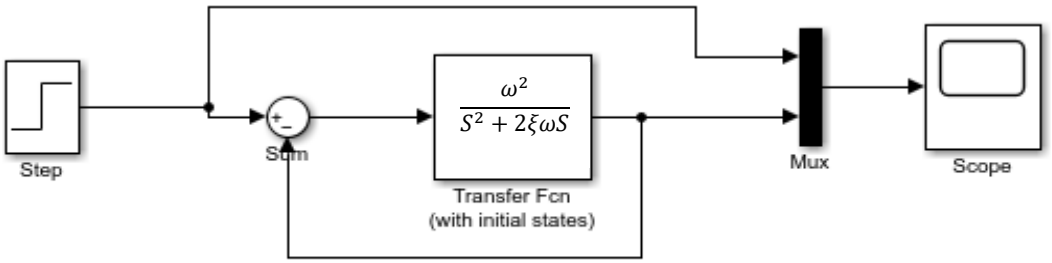


Fig. (1): Block diagram in MATLAB.

Procedure:

1- Using Matlab and Simulink connect the circuit shown in figure (1),

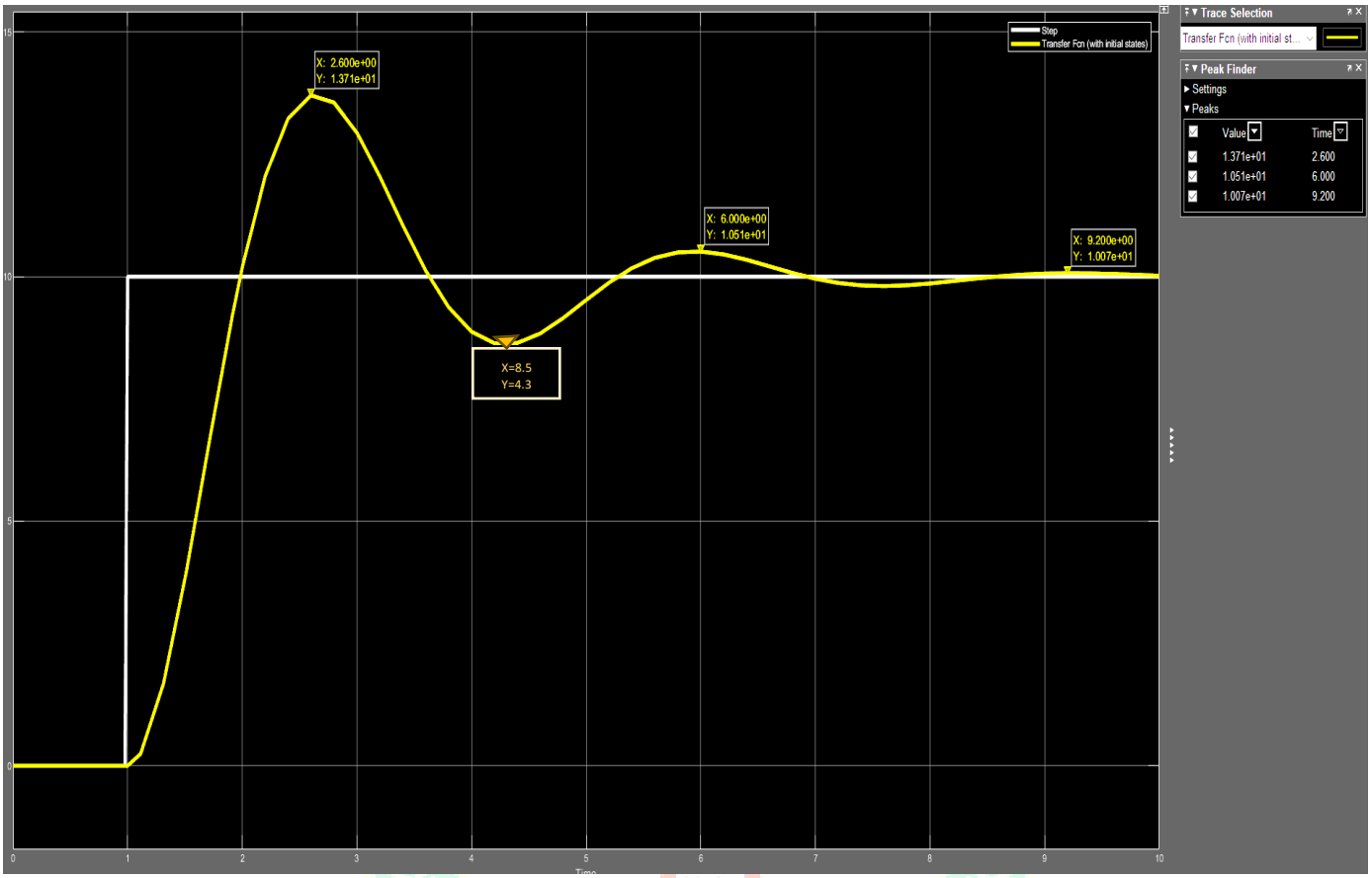
show the unit step response y (t) on personal computer for the values in the tables:

Then sketch the system response for each value.

A. $\omega_n = 2$ $\xi = 0.3$	B. $\omega_n = 2$ $\xi = 0.7$	C. $\omega_n = 2$ $\xi = 1$ " In Lab."

D. $\omega_n = 0.5$ $\xi = 0.7$ Homework	E. $\omega_n = 1$ $\xi = 0.7$ Homework	F. $\omega_n = 4$ $\xi = 0.7$ Homework

For the A cell ($\omega_n = 2$, $\xi = 0.3$)

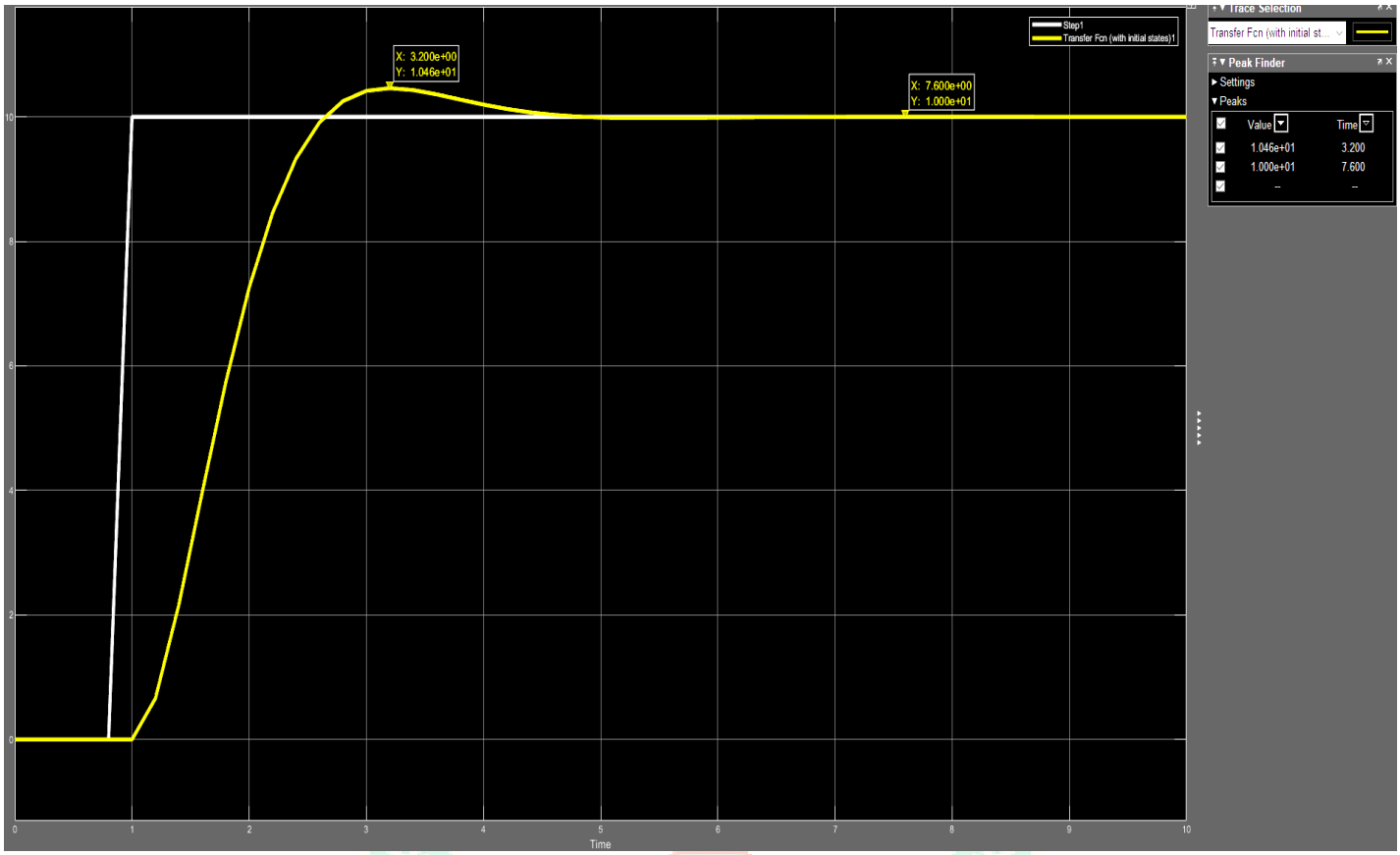


Mp=13.71 at tp=2.6

First ***ts*** at y=4.3

The second ***ts*** at y =6

For the B cell. (ω_n =2, ξ=0.7)



Mp=10.46 at tp=3.2

ts at y=7.6