Control and Instrumentation Lab Report
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1. Aim of the experiment

To obtain time response of a second-order system in case of under damped, overdamped, and critically damped systems.

2. Theory

The time response of the control system consists of two parts. Transient response and steady state response. C(t) = Ctr(t) + Css(t). Most of the control systems use time as its independent variable. Analysis of response means to see the variation of output with respect to time. The output of the system takes some finite time to reach to its final value. Every system has a tendency to oppose the oscillatory behaviour of the system which is called damping. The damping is measured by a factor called damping ratio of the system. If the damping is very high then there will be any oscillations in the output. The output is purely exponential. Such system is called an over damped system.

If the damping is less compared to over damped case then the system is called a critically damped system. If the damping is very less than then the system is called under damped system. With no damping system is undamped.

3. Apparatus Required

A laptop loaded with MATLAB

4. Procedure

Open the MATLAB command window

1. Click on file-new M file to open the MATLAB editor window

2. In the given MATLAB editor window enter the program to obtain the step response

CODE

```
clc;
clear all;
wn=input('Enter the value of Wn: ');
zeta=input('Enter the value of Zeta: ');
num=[wn*wn];
den=[1 2*zeta*wn wn*wn];
sys=tf(num, den);
step(sys);
```

3. Save the file in work directory

4. Run the program and enter the respective value for natural frequency, damping ration and time

5. The graphs displayed are according to the above values

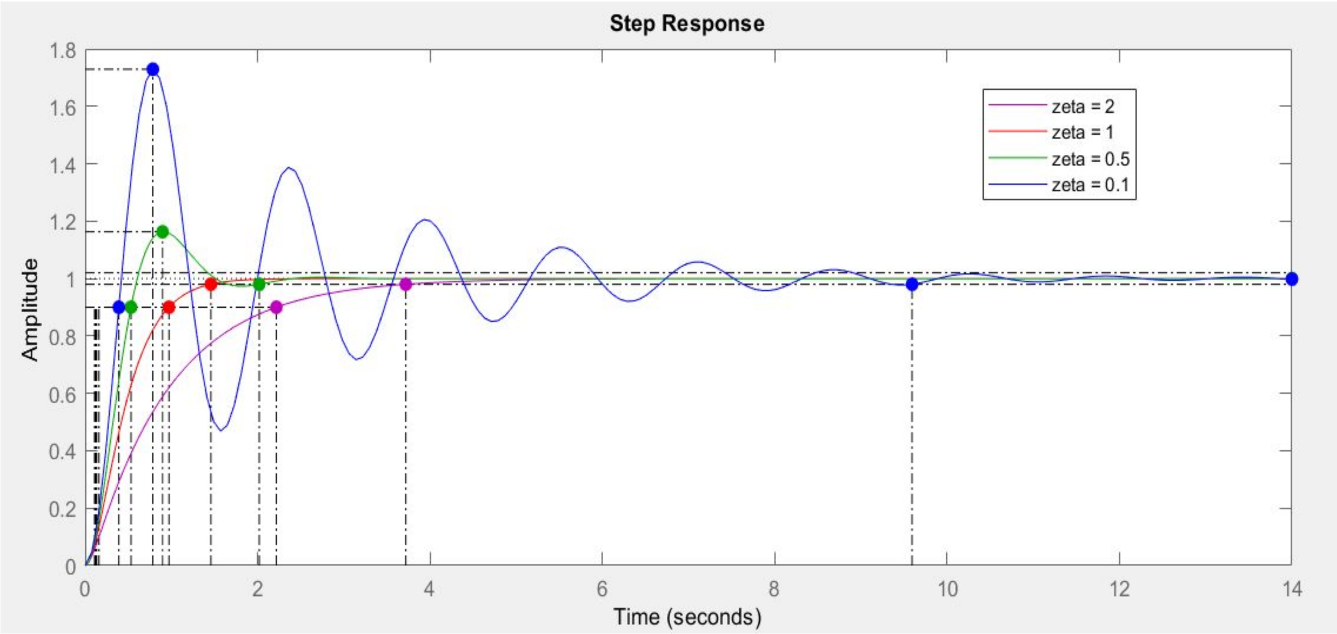
6. The values of wd, td, theta, tr ts, Mp can be obtained by

   a) Right click on the figure window and select grid to get grids on the curve

   b) Right click on the figure window and select characteristics and enable peak response, settling time & rise settling.

   c) Repeat the steps 5,6,7 for different values of Theta

5. Graph



6. Tabular Columns

Theta = 2

Time Domain Specification	From MATLAB	By Calculation	Error(%)
Rise Time	1.36	1.52	11.76%
Peak Time	Inf	Inf	NA
Settling Time	2.47	2.501	1.25%
Max. Overshoot	0	0	0

Theta = 1

Time Domain Specification	From MATLAB	By Calculation	Error(%)
Rise Time	0.84	0.748	10.95%
Peak Time	Inf	Inf	NA
Settling Time	1.46	1.348	7.67%
Max. Overshoot	0	0	0

Theta = 0.5

Time Domain Specification	From MATLAB	By Calculation	Error(%)
Rise Time	0.41	0.441	7.56%
Peak Time	0.898	0.906	0.89%
Settling Time	2.02	2.00	1%
Max. Overshoot	16.3	16.31	0.06%

Theta = 0.1

Time Domain Specification	From MATLAB	By Calculation	Error(%)
Rise Time	0.282	0.301	6.73%
Peak Time	0.786	0.793	0.89%
Settling Time	9.59	10.00	4.27%
Max. Overshoot	72.9	72.97	0.1%

7. Conclusion

From the above observation table, we have successfully analysed the time response of a second order system in **under damped, over damped** and **critically damped** systems. The theoretical and simulation data values differed with a percent error in range of **2% to 10%** approximately, which **validates time response of second order systems.**

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