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Response analysis of first order and second order system using LabVIEW

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***Abstract*-This paper introduce useful concept for transient response analysis for first order and second order system using graphical programming language - LabVIEW. Transient response analysis is the most useful method for computing dynamic response. The response of a process provides necessary information regarding the behavior of the system. The computation of parameters for first and second order system can be estimated efficiently using LabVIEW.The inter relation between different parameters can be computed effectively using LabVIEW.**

***Index terms* –First order, second order, Transient Response analysis, LabVIEW.**

I. INTRODUCTION

The design of a control system depends on various parameters. The useful parameters of a system like stability, accuracy, peak overshoot and other transient parameters can be determined for the first and second order system. Using a successful tool like LabVIEW, we can effectively provide the response analysis, which will be helpful in designing the system more efficiently. LabVIEW is a graphical programming language which is very user friendly as it deals with a graphical view of the process, which is easier for a beginner to understand. LabVIEW contains many useful toolboxes for the effective design of a Control Sytstem. This paper uses the Control system toolbox for the estimation of different transient parameters of the given first and second order system. The effect of one parameter on the other parameter can be easily determined using LabVIEW. The different kind of toolbox available with LabVIEW such as Control System toolbox, Digital Signal processing toolbox and Report generation toolbox provides total response of the system, which can be easily logged in different suitable format [1] [2].

II. FIRST ORDER SYSTEM

Order of the system is the highest power of ‘s’ in the denominator of a close loop transfer function. The dynamics of many systems of interest to engineers may be represented by a simple model containing one independent energy storage element.[3][4]

$$G(s)=\frac{Y(s)}{R(s)}=k\frac{a}{s+a}=k\frac{1}{\tau s+1}$$

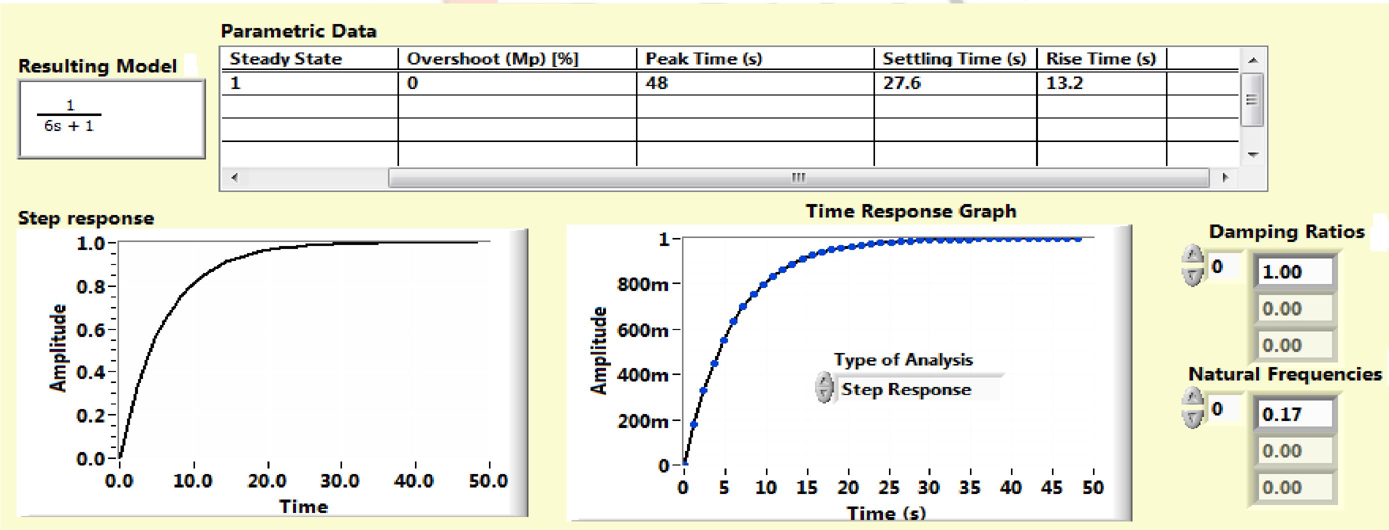

Figure 1. Step response and parametric data of the given first order system using LabVIEW

The transfer function of the first order system is seen in the figure 1 resulting model. After performing the analysis, figure 1 shows the step response and parametric data of the given first order system using LabVIEW. It can be observed that the natural frequencies and damping ratios are estimated along with the other parametric data.

III. SECOND ORDER SYSTEM

Compared to the of a first-order system, a second-order system exhibits a wide range of responses such as damping factor, damping coefficient etc. that must be analyzed. Comparing with the first order system which affects the speed and offset of the response, the second order system changes the whole dynamics of the process.[3][4]

$$G(s) = \frac{K}{s(s+p)} = \frac{\omega_n^2}{s(s+2\zeta\omega_n)}$$

$$T_{CL} = \frac{K}{s^2+ps+K} = \frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$$

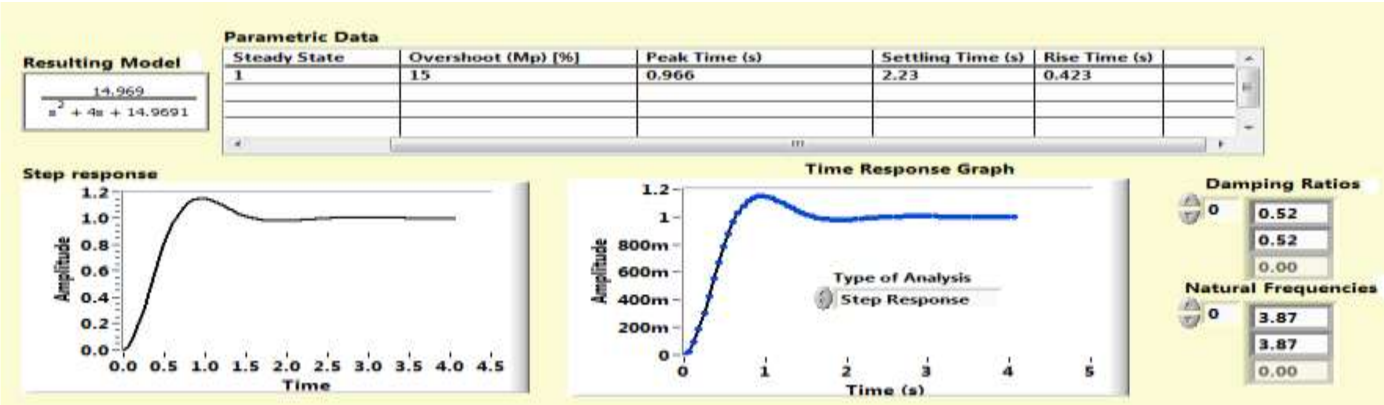

Figure 2 Step response and parametric data of the given second order system using LabVIEW

The transfer function of the first order system is seen in the figure 2 resulting model. After performing the analysis, figure 2 shows the step response and parametric data of the given second order system using LabVIEW. It can be observed that the natural frequencies and damping ratios are estimated along with the other parametric data. Further, as we are dealing with the second order system, the effect of damping on the system needs to be studied.

CASE 1: Zeta > 1

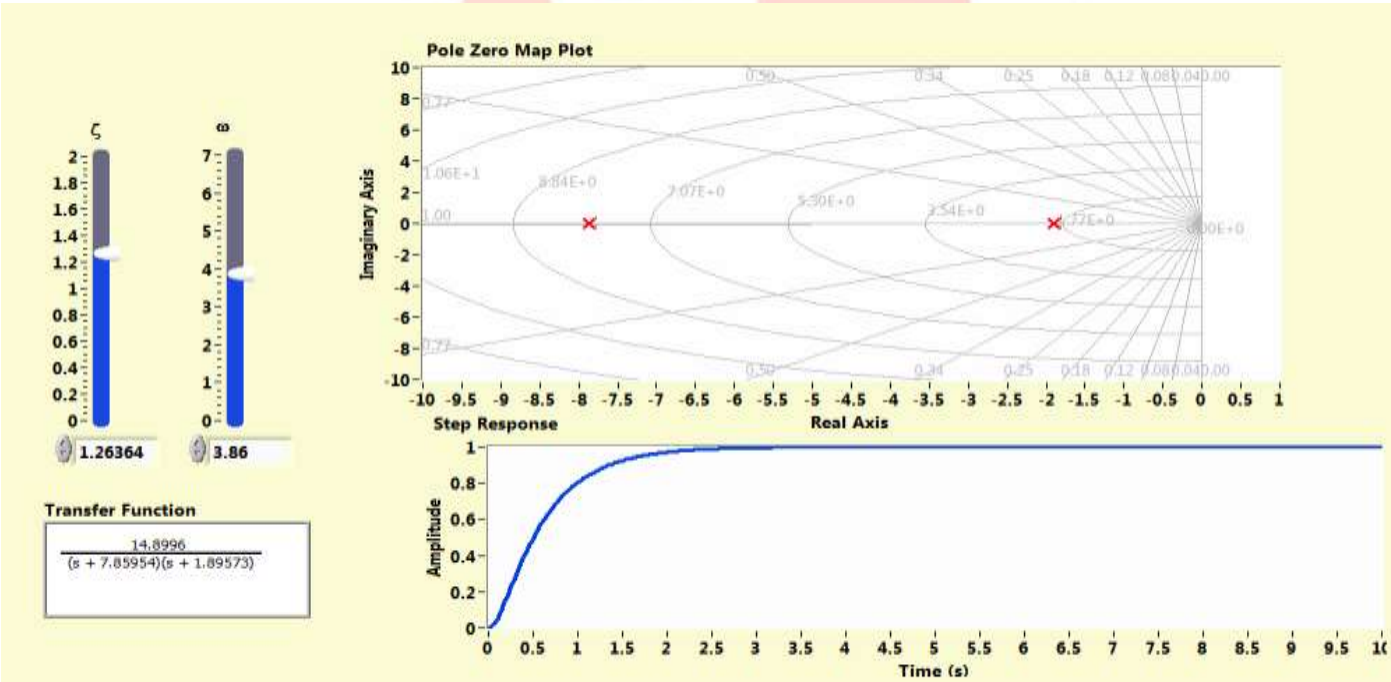

Figure 3 Effect of damping (Zeta >1) on the given second order system using LabVIEW

As per the observation from figure 3, the effect of damping is clearly seen. Increasing the value of damping factor Zeta to be greater than 1, the system becomes overdamped killing all the oscillations and giving a smooth output for the given model.

CASE 2: Zeta < 1

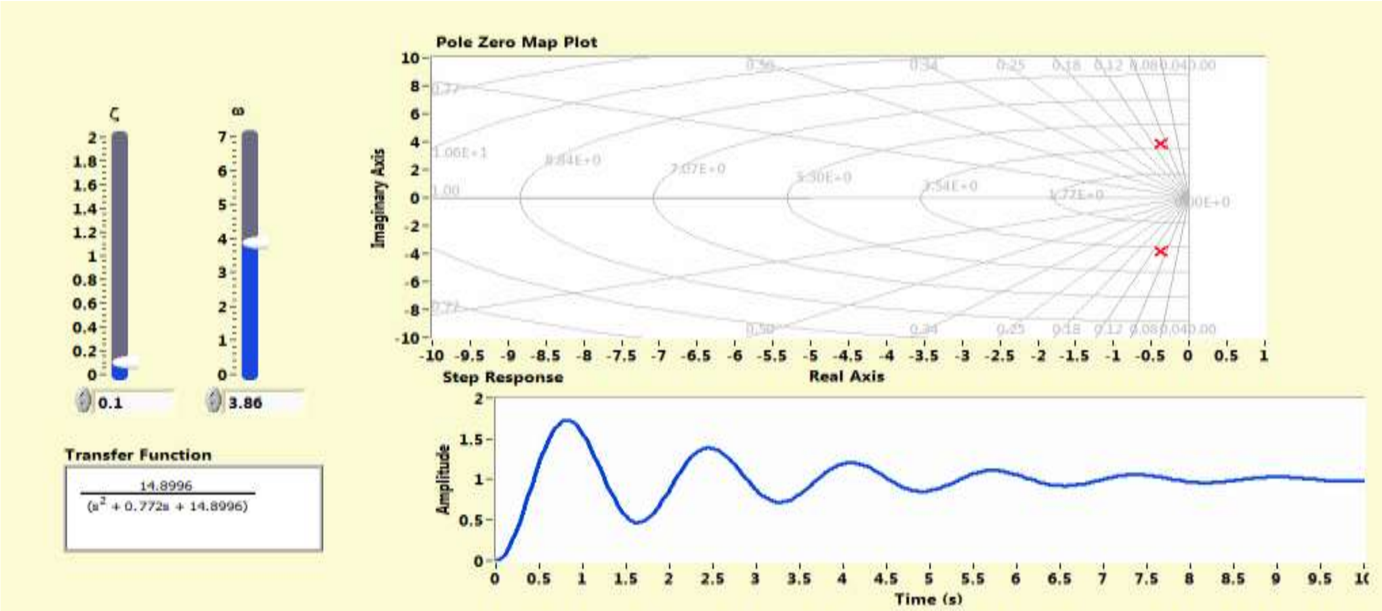

Figure 4 Effect of damping (Zeta <1) on the given second order system using LabVIEW

As per the observation from figure 4, the effect of damping is clearly seen. Increasing the value of damping coefficient Zeta to be less than 1, the system becomes underdamped. Comparing to the Overdamped system, here oscillations are observed in the given model.

IV. CONCLUSION

This paper describes the transient response analysis of first order and second order system. It is observed that LabVIEW provides multiple window display for correlating various transient parameters. The system analysis is done by Control System Toolbox of LabVIEW and thus first and second order system is being successfully analyzed.

V. REFERENCES

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