IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 7.047 ⁜ Vol. 10, Issue 10, October 2022

DOI: 10.17148/IJIREEICE.2022.101004

Evaluation of transient response specifications of second order control system using Scilab

Sukeshini S.Tabhane[1], Suryasevak Singh[2] , Shital Deshmukh[3]

Lecturer, Electronics & Telecomm, BVIT, Navi Mumbai, India [1]

Lecturer, Electronics & Telecomm, BVIT, Navi Mumbai, India [2]

Lecturer, Electronics & Telecomm, BVIT, Navi Mumbai, India [3]

Abstract: The second-order system is the lowest-order system capable of an oscillatory response to a step input. The response depends on whether it is an overdamped, critically damped, or underdamped second order system. Here we will find out transient response specifications of second order system. This system can be implemented using MATLAB software. But MATLAB software requires licence. In this paper, second order system is implemented using Scilab software. Scilab is an open source software and therefore the responses of second order system is implemented using Scilab.

Keywords: Scilab, response, damping, specifications, transient

I. INTRODUCTION

Scilab is an engineering tool which is capable of numerical computations, data analysis and plotting, system modeling and simulation, and offers application designing with the help of GUI (Graphical User Interface), embedding Scilab in C/C++. Basically, Scilab is an interpreted language. This generally allows to get faster development processes, because the user directly accesses to a high level language, with a huge set of features provided by the library. Users can design their own module to solve particular problems. Scilab can also interface LabVIEW, which is a visual programming language from National Instruments.

II. ANALYSIS OF SECOND ORDER SYSTEM

The response of a second order system is more complex as compared to first order system. Whereas the step response of a second order system is also much more complex as compared to first order system. The form of a second order transfer function is given by:

$$\frac{Y(s)}{X(s)} = \frac{as^2+bs+c}{s^2+ds+e}$$

where a, b, c, d and e are arbitrary real numbers and at least one of the numerator terms is non-zero.

The order of a control system is determined by the power of 's' in the denominator of its transfer function. If the power of s in the denominator of the transfer function of a control system is 2, then the system is said to be second order control system. The general expression of the transfer function of a second order control system is given as

$$\frac{Y(s)}{X(s)} = \frac{wn^2}{s^2+2\xi wns+wn^2}$$

Here, ξ and ωn are the damping ratio and natural frequency of the system, respectively.

After applying input to the control system, output takes certain time to reach steady state. So, the output will be in transient state till it goes to a steady state. Therefore, the response of the control system during the transient state is known as transient response. The performance of the control system are expressed in terms of transient response

Following are the common transient response characteristics:

- Delay Time.
- Rise Time.
- Peak Time.
- Peak Overshoot.
- Settling Time.

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 7.047 ⁜ Vol. 10, Issue 10, October 2022

DOI: 10.17148/IJIREEICE.2022.101004

III. SCILAB CODE

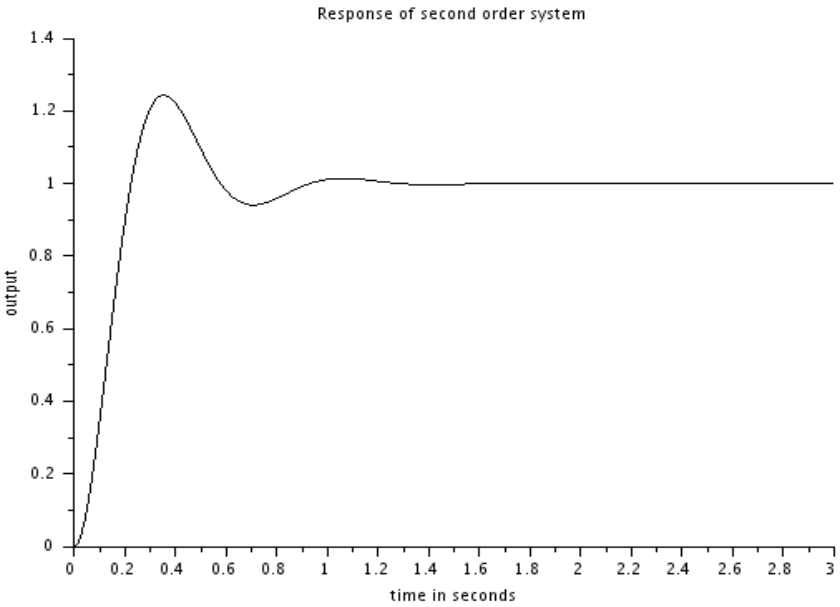
Scilab code:

```
s=poly(0,'s');
T=syslin('c',95,95+8*s+s^2);
t=0:0.0005:3;
TF=csim('step',t,T);
plot2d(t,TF);
title('Response of second order system');
xlabel('time in seconds ')
ylabel('output')
y=denom(T);z=coeff(y)
wn=sqrt(z(1,1))
zeta=z(1,2)/(2*wn)
wd=wn*sqrt(1-zeta^2)
Tp=%pi/wd //Peak time
Mp=100*exp((-%pi*zeta)/sqrt(1-zeta^2))//Peak
Overshoot
Td=(1+0.7*zeta)/wn //Delay time
theta=atan(sqrt(1-zeta^2)/zeta)
Tr=(%pi-theta)/wd // Rise time
Ts=4/(zeta*wn) // Settling time
```

Result:

```
z  =
   95.    8.    1.
wn  =
   9.7467943
zeta  =
   0.4103913
wd  =
   8.8881944
Tp  =
   0.3534568
Mp  =
   24.32107
Td  =
   0.1320715
theta  =
   1.1479132
Tr  =
   0.2243065
Ts  =
   1.
```

IV. SIMULATION RESULT

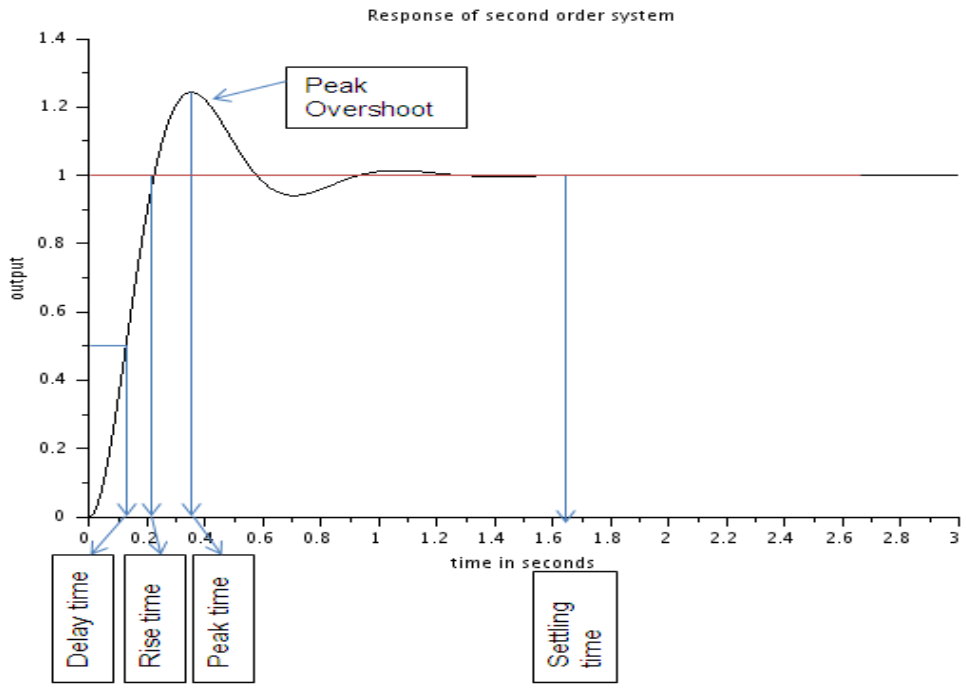


IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 7.047 ⁜ Vol. 10, Issue 10, October 2022

DOI: 10.17148/IJIREEICE.2022.101004



V. CONCLUSION

Thus it has been observed that the accuracy of transient response depends upon the time steps. After certain time constant output reaches to its steady state.

REFERENCES

[1] 2018 IEEE 4th International Symposium in Robotics and Manufacturing Automation (ROMA) Design and Analysis of Fractional-order Filters Using Scilab by Kishore Bingi1, Rosdiazli Ibrahim, Mohd Noh Karsiti, Sabo Miya Hassan and Vivekananda Rajah Harindran

[2] James W. Demmel. Applied Numerical Linear Algebra. SIAM, 1997.

[3] Arieh Iserles. A First Course in the Numerical Analysis of Differential Equations. Cambridge Texts in Applied Mathematics. Cambridge University Press, second edition, 2009.

[4] Jeremy Kepner. Parallel MATLAB for Multicore and Multimode Computers. SIAM, 2009.

[5] Neeraj Sharma and Matthias K. Gobbert. Performance studies for multithreading in Matlab with usage instructions on hpc. Technical Report HPCF–2009–1, UMBC High Performance Computing Facility, University of Maryland, Baltimore County, 2009