ELEC 341 – Graded Assignments

Assignment A2
2^{nd} Order Approximations

10 Marks

Learning Objectives

Modeling Black Box Systems
2^{nd} Order Performance Metrics
Natural Frequency
Damping Co-efficient
2^{nd} Order Approximations

Matlab
- zpk()
- a2DSPlot()

When you use off-the-shelf (OTS) sub-components, you only have the information available in the data-sheet about what's inside. This is called a "Black Box" system.

*Data sheets often contain experimental curves, but rarely provide a linear model. To use the device in a control system, you must develop one of your own. The best you can do is a linear approximation which will never be perfect, but It's better than nothing. And if you do a good job, it's **a lot** better than nothing.*

Q1 2 mark(s) Experimental Data from a Data-Sheet

Use **a2DSPlot.p** to plot an experimental curve from a data-sheet.

Estimate Rise Time (Tr), Modified Rise Time (Tr1), Time Constant (Tau), Peak Time (Tp), Settle Time (Ts), and Percent Overshoot (Pos).

- Q1.Tr (ms) Scalar
- Q1.Tr1 (ms) Scalar
- Q1.Tau (ms) Scalar
- Q1.Tp (ms) Scalar
- Q1.Ts (ms) Scalar
- Q1.Pos (%) Scalar

The data has noise, which doesn't make your task particularly easy, but it's experimental data and that's what experimental data looks like.

Answer this question carefully. The whole assignment depends on these values.

Q2 1 mark(s) Damping Co-efficient

Compute the damping co-efficient ζ.

- Q2.zeta (pure) Scalar

Q3 1 mark(s) Approximate #1

Use **Rise Time** to compute natural frequency ωn.

Use ζ and ωn to compute a 2^{nd} Order Approximation transfer function G.

- Q3.wn (rad/s) Scalar
- Q3.G (V/V) LTI

Q4 1 mark(s) Approximate #2

Use **Peak Time** to re-compute natural frequency ωn.

Use ζ and ωn to compute a 2^{nd} Order Approximation transfer function G.

- Q4.wn (rad/s) Scalar
- Q4.G (V/V) LTI

Q5 1 mark(s) Approximate #3

Use **Settle Time** to re-compute natural frequency ωn.

Use ζ and ωn to compute a 2^{nd} Order Approximation transfer function G.

- Q5.wn (rad/s) Scalar
- Q5.G (V/V) LTI

Q6 1 mark(s) Approximate #4

Use both **Rise Time** and **Peak Time** to compute natural frequency ωn.
Use the mean of the two natural frequencies you already calculated.
Use ζ and ωn to compute a 2nd Order Approximation transfer function G.

• Q6.wn	(rad/s)	Scalar
• Q6.G	(V/V)	LTI

Q7 1 mark(s) Approximate #5

Use both **Rise Time** and **Settle Time** to compute natural frequency ωn.
Use the mean of the two natural frequencies you already calculated.
Use ζ and ωn to compute a 2nd Order Approximation transfer function G.

• Q7.wn	(rad/s)	Scalar
• Q7.G	(V/V)	LTI

***COW**: Plot the step response of each transfer function.*

*Are the target metrics of each approximation **identical** to the source function ???*

Do any of them reach 98% of FV at 4τ ???

Plot all approximations on the same figure. If you were developing an approximation of a real system, you would choose the most appropriate one, based on your particular RCGs.

Q8 1 mark(s) Approximate #6

Compute the damping co-efficient ζ and natural frequency ωn of a 2nd Order Approximation that has the same **Peak Time** and **DC Gain** as Q3, but **1/2 the Overshoot**.

• Q8.zeta	(pure)	Scalar
• Q8.wn	(rad/s)	Scalar
• Q8.G	(V/V)	LTI

Q9 1 mark(s) Approximate #7

Use the time constant **Tau τ** to compute a 2nd Order Approximation transfer function that is **Critically Damped**.

• Q9.wn	(rad/s)	Scalar
• Q9.G	(V/V)	

***COW**: Plot the step response of each transfer function.*

Do your approximations satisfy all requirements ???