ELEC 341 – Graded Assignments

Assignment A2
2nd Order Approximations

100 Marks

Required Files

Available on Canvas

- **e341-a2.pdf** *Assignment description (this document)*
- **a2DSPlot.p** Data-Sheet curve generator
- **a2Submit.p** *Grading script (**LATEST** version)*
- **e341-APE.pdf** *Instructions for submitting graded work (for reference)*

Topics

Under-Damped 2nd Order Systems
- performance metrics

Noise
- analog & digital

Over-Damped 2nd Order Systems
- effective time constant

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

Data sheets often contain experimental curves, but rarely a linear model.

Use **a2DSPlot.p** to plot 3 experimental curves from a data-sheet.

Curve #1 is the step response of an **ACTUAL** 2nd order under-damped system

The time scale isn't long enough to show settle-time directly. This is a common problem.

Find the envelope, and from that estimate final value **FV**.

Find overshoot $\mathbf{OS_y}$, and use it to find damping co-efficient $\boldsymbol{\zeta}$.

Find rise-time $\mathbf{T_r}$ and peak-time $\mathbf{T_p}$, and use either to find natural frequency $\boldsymbol{\omega_n}$.

Use $\boldsymbol{\zeta}$ and $\boldsymbol{\omega_n}$ to find settle-time $\mathbf{T_s}$.

1. 20 mark(s) Settle Time #1

• Q1.FV	(V)	Scalar
• Q1.OSy	(%)	Scalar
• Q1.zeta	(pure)	Scalar
• Q1.Tr	(s)	Scalar
• Q1.Tp	(s)	Scalar
• Q1.wn	(rad/s)	Scalar
• Q1.Ts	(s)	Scalar

***COW**: **FV** and **Ts** are approximations. Some adjustments may be necessary.*

Curve #2 is the step response of a **higher** order under-damped system.

The data is noisy so you cannot read off any values with much accuracy. You must estimate what the actual curve would be if there were no white noise.

Find Overshoot $\mathbf{OS_y}$. Use it to find damping co-efficient $\boldsymbol{\zeta}$.

Find rise-time $\mathbf{T_r}$. Use it to find natural frequency $\boldsymbol{\omega_{nr}}$.

Use $\boldsymbol{\zeta}$ and $\boldsymbol{\omega_{nr}}$ to find a 2nd order approximation **G**.

2. 25 mark(s) Rise Time #2

• Q2.OSy	(%)	Scalar
• Q2.Tr	(s)	Scalar
• Q2.zeta	(pure)	Scalar
• Q2.wnr	(rad/s)	Scalar
• Q2.G	(V/V)	LTI

Find peak-time $\mathbf{T_p}$. Use it to find natural frequency $\boldsymbol{\omega_{np}}$.

Use $\boldsymbol{\zeta}$ and $\boldsymbol{\omega_{np}}$ to find a 2nd order approximation **G**.

3. 15 mark(s) Peak Time #2

• Q3.Tp	(s)	Scalar
• Q3.wnp	(rad/s)	Scalar
• Q3.G	(V/V)	LTI

Find settle-time $\mathbf{T_s}$. Use it to find natural frequency $\boldsymbol{\omega_{ns}}$.

Use $\boldsymbol{\zeta}$ and $\boldsymbol{\omega_{ns}}$ to find a 2nd order approximation **G**.

4. 15 mark(s) Settle Time #2

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

Curve #3 is the step response of a **2nd** order over-damped system.

It is difficult to accurately read time values from sampled data. Estimate the continuous curve and get your time values from that.

Estimate the time constant τ, and modified rise-time **Tr1**.

Use τ and **Tr1** to find damping co-efficient $\boldsymbol{\zeta}$.

5. 15 mark(s) Damping Coefficient

- Q5.tau (s) Scalar
- Q5.Tr1 (s) Scalar
- Q5.zeta (pure) Scalar

COW: *When data is sampled, it starts out accurate, and degrades as it is held.*

Use modified rise-time **Tr1** to find natural frequency $\boldsymbol{\omega_{n1}}$.

Use $\boldsymbol{\zeta}$ and $\boldsymbol{\omega_{n1}}$ to find a 2nd order approximation **G**.

6. 10 mark(s) Over-Damped Approx

- Q6.wn1 (rad/s) Scalar
- Q6.G (V/V) LTI

COW: *Would a 1st order approximation be just as accurate ???*
Compute it, plot it and compare.