http://elec3004.com

An Introduction to Digital Linear **Systems: Signals & Controls**

Welcome!

ELEC 3004: **Systems**: Signals & Controls
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Lecture 1 Quiz Solutions and More!

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Prere-***quiz***-ite Solutions ☺

Q1: Complex Solutions to Real Problems

Can an ODE with only real constant coefficients have a complex solution?

- Yes, because the coefficients do not give the solution, but rather setup an equation that instead gives a solution
- For example:

$$y'' + y = 0$$

- Has solutions:

$$e^{ix} \text{ and } e^{-ix}$$

Q2: Transfer Functions and the s-Domain [1]

Final Value Theorem

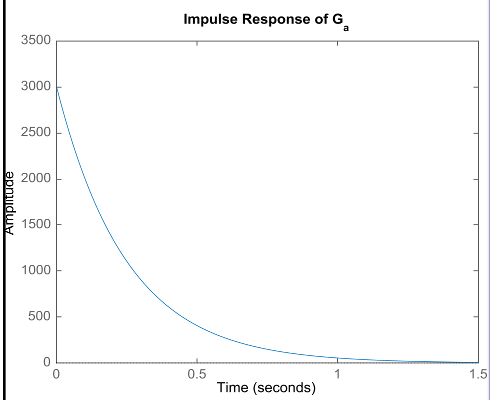
$$\lim_{t\to\infty} f(t) = \lim_{s\to 0} sF(s)$$

Latex Version:
$\lim_{t\to\infty} f(t) = \lim_{s\to 0} sF(s)$

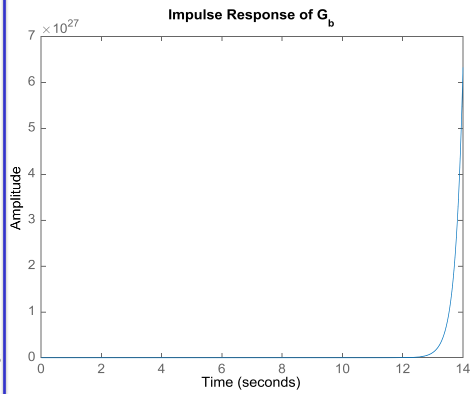
- For systems that are valid (i.e., stable):
  - Roots of the denominator of $\boldsymbol{H(s)}$ must have negative real parts.
  - $\boldsymbol{H(s)}$ must not have more than one pole at the origin.

Q2: Transfer Functions and the s-Domain [2]

- $G_a(s) = \frac{3004}{s+4}$

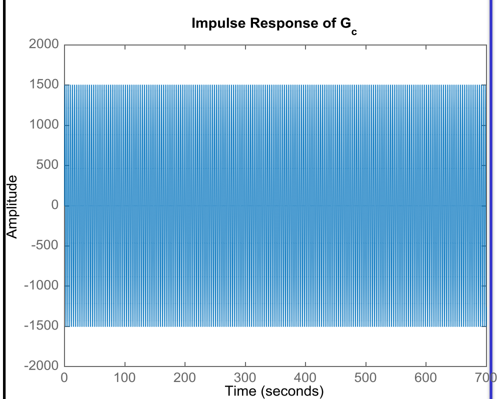


- $G_b(s) = \frac{3004}{s-4}$

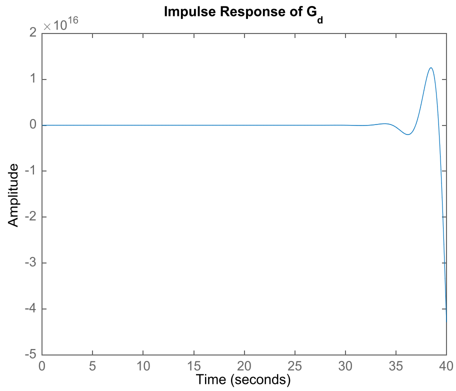


Q2: Transfer Functions and the s-Domain [3]

- $G_c(s) = \frac{3004}{s^2+4}$

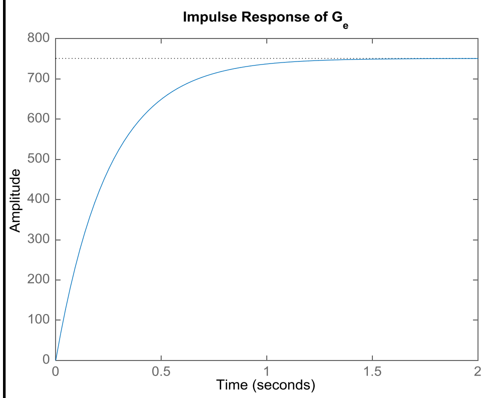


- $G_d(s) = \frac{3004}{s^4+4}$

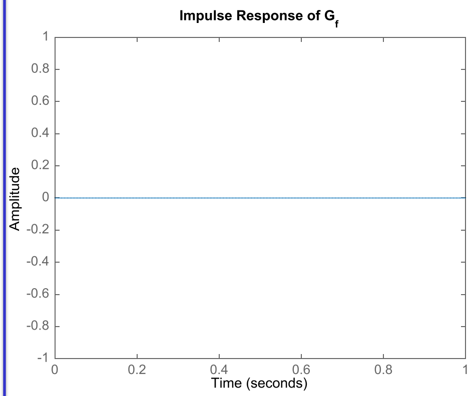


Q2: Transfer Functions and the s-Domain [4]

- $G_e(s) = \frac{3004}{s^2+4s}$

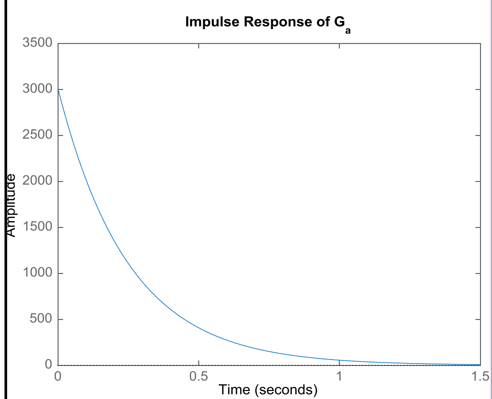


- $G_f(s) = \frac{3004}{4} = 751$
- Not a "dynamic system"

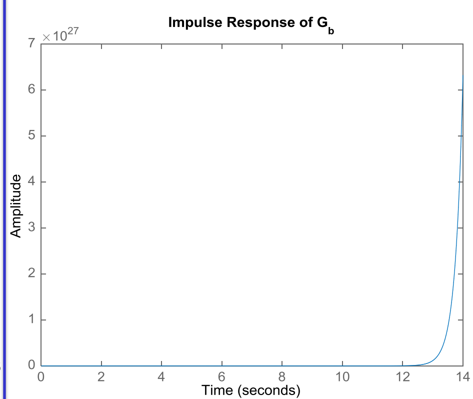


Q2: Transfer Functions and the s-Domain [2]

- $G_a(s) = \frac{3004}{s+4}$



- $G_b(s) = \frac{3004}{s-4}$



Q2: Transfer Functions and the s-Domain [5] Matlab Source for Graphs

```
%% ELEC 3004 Quiz 0 -- Q2
% Ga
a=[3004]; b=[1 4]; Ga=tf(a, b);  figure(10);
impulse(Ga);  title('Impulse Response of G_a');
% Gb
a=[3004]; b=[1 -4]; Gb=tf(a, b);  figure(20);
impulse(Gb); title('Impulse Response of G_b');
% Gc
a=[3004]; b=[1 0 4]; Gc=tf(a, b);  figure(30);
impulse(Gc); title('Impulse Response of G_c');
% Gd
a=[3004]; b=[1 0 0 4]; Gd=tf(a, b);  figure(40);
impulse(Gd); title('Impulse Response of G_d');
% Ge
a=[3004]; b=[1 4 0]; Ge=tf(a, b);  figure(50);
impulse(Ge); title('Impulse Response of G_e');
% Gf
a=[3004]; b=[4]; Gf=tf(a, b);  figure(60);
impulse(Gf); title('Impulse Response of G_f');
```


Q3: Free Determination

- False:

$$\det(A + B) \neq \det(A) + \det(B)$$

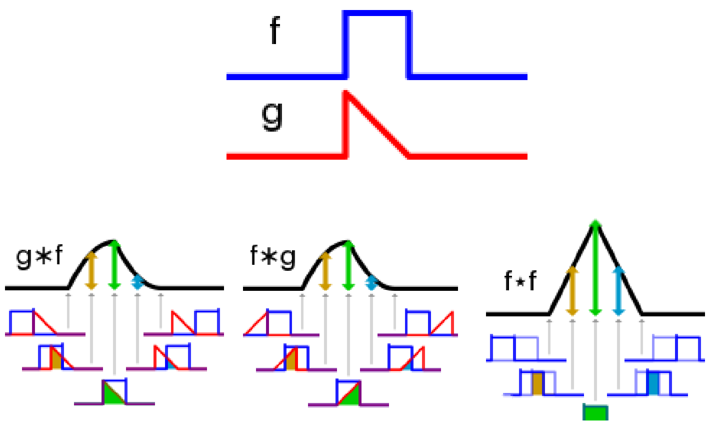
- True:

$$\det(AB) = \det(A) \cdot \det(B)$$

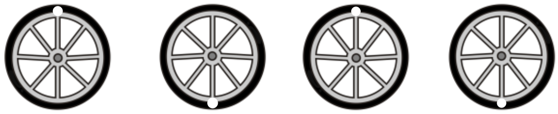
Q4: Free Determination : All TRUE

- True:
  $A = LU$: is a factorization that is basically an elimination
- True:
  If $\boldsymbol{A}$ is invertible, then the only solution to $\boldsymbol{Ax} = \mathbf{0}$ is $\boldsymbol{x} = \mathbf{0}$.
- True:
  Linear Equations ($Ax = b$) come from steady-state problems.
  eigenvalues ($Ax = \lambda x$) have importance in dynamic problems.

Q5: Convolution!: All TRUE



Q6: A Signal Re-volution!



Frame 1 Frame 2 Frame 3 Frame 4

A. It could be rotating either way (CW or CCW). The angular velocity is $\dot{\theta} = \frac{\Delta\theta}{\Delta t} = \left[\frac{(2n+1)\pi}{\frac{1}{25}}\right] \Rightarrow 12.5\ rev/second$

B. Speeds (m/s):

$$\mathrm{v} = \omega \times r = 25\pi\,\frac{rad}{s} \cdot (0.32\ m) = 25.1\,\frac{m}{s} = 90.5\ kmh$$

C. $\text{Speed}_{\text{car}} \stackrel{?}{=} \text{Speed}_{\text{wheel}}$:

- Straight line (no turning)
- Full traction
- No suspension effects …
- What is the **frame of reference**? Should be picked with care!

Next Time…

- We'll talk about System Models
- Review:
  - Phasers, complex numbers, polar to rectangular, and general functional forms.
  - Chapter 1 of Lathi (particularly the first sections on signals & classification thereof)
- Register on Platypus
- Try the practise assignment (will be posted soon)