

EE 1130

Freshman Eng. Design for Electrical and Computer Eng.

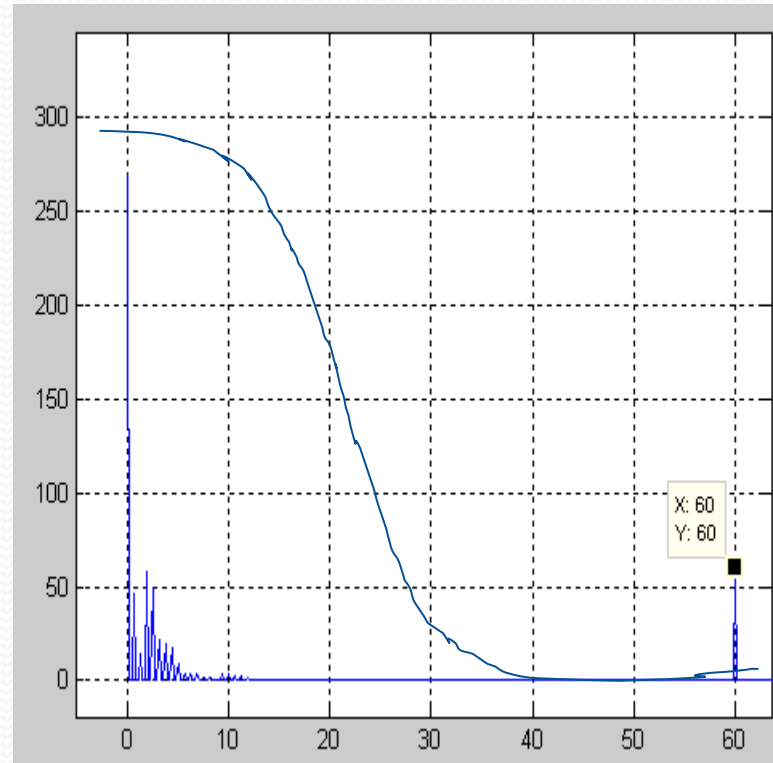
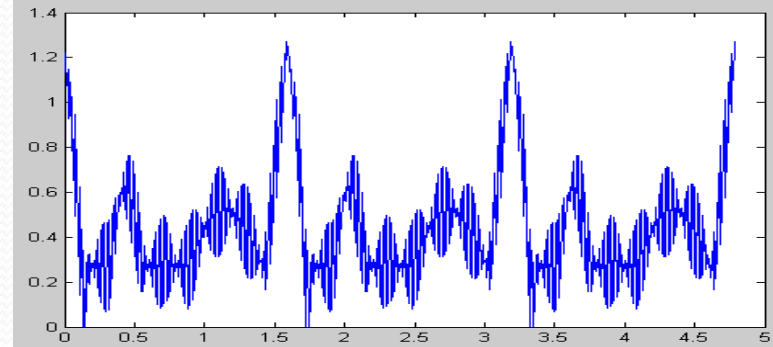
Class 5

Signal Processing Module (DSP).

- Digital Filter Design to solve the noisy EKG problem.
- Module Project.
 - i. Recognition of need for and ability to engage in lifelong learning.

EKG Example.

- To solve the EKG noisy problem we need to use Digital Filters.
- Digital Filters use the Z-transform instead of the Laplace Transform. The concepts of Pole-Zero and frequencies are the same.
- If we analyze the EKG signal (in the frequency domain) we see the frequency components in the next figure:
 - There are a lot of components below 10Hz.
 - There is a component in 60Hz, we must kill!!



EKG Example.

- One aspect to take into account is the sampling frequency (fs) to avoid the ALIASING effect (Nyquist Theorem).
- The frequencies to kill that have to be placed in the numerator (same as in Laplace Transform). However, the s frequency must be translated to the z variable as follows:

$$(s = 2\pi 60j) \rightarrow z = e^{-j2\pi 60 fs}$$

EKG Example.

- In our problem the sampling frequency is $f_s=1000/8\text{Hz}$ ($t_s=8/1000$), therefore the zeros of the transfer function must be:

$$z - e^{-j2\pi 60(1000/8)}$$

$$z + e^{-j2\pi 60(1000/8)}$$

- The numerator is:

$$(z - e^{-j2\pi 60(1000/8)}) * (z + e^{-j2\pi 60(1000/8)})$$

- That creates a numerator of:

$$z^2 + 1.9842z + 1$$

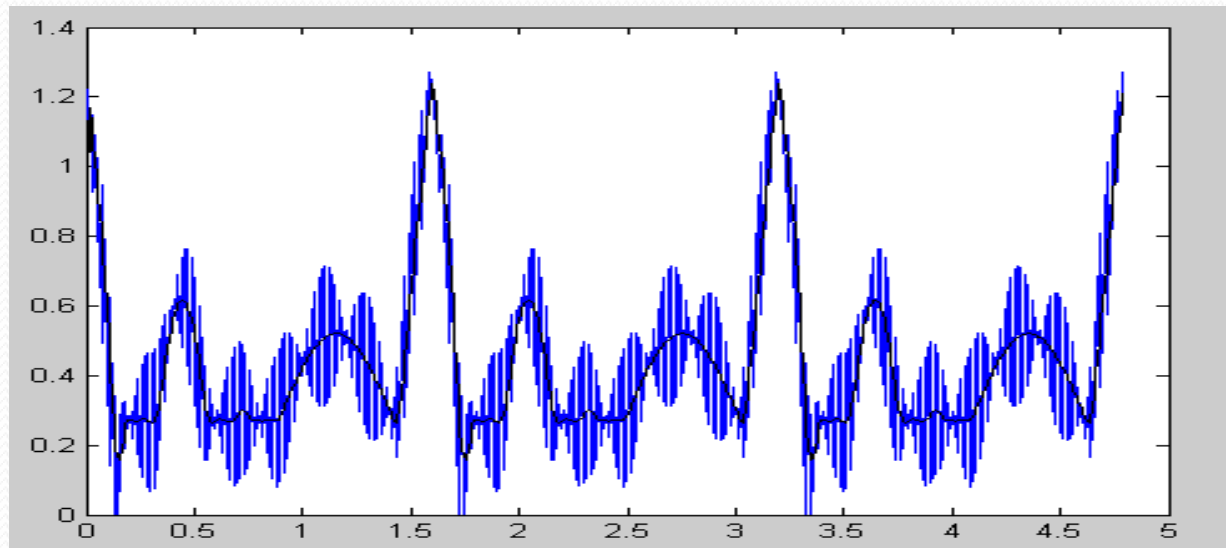
- We let the denominator to be $z=1$

EKG Example.

- The final Transfer Function in the Z domain is:

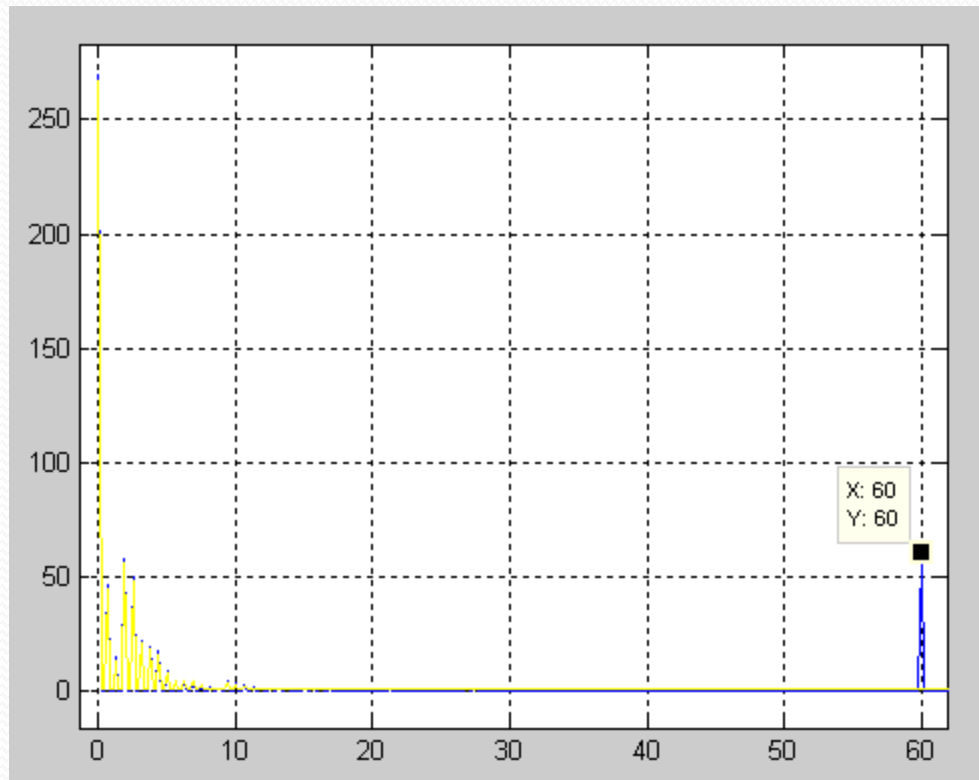
$$H(z) = \frac{z^2 + 1.984z + 1}{1}$$

- Now I need to simulate this filter and apply the noisy EKG signal to see the output of the filter.



EKG Example.

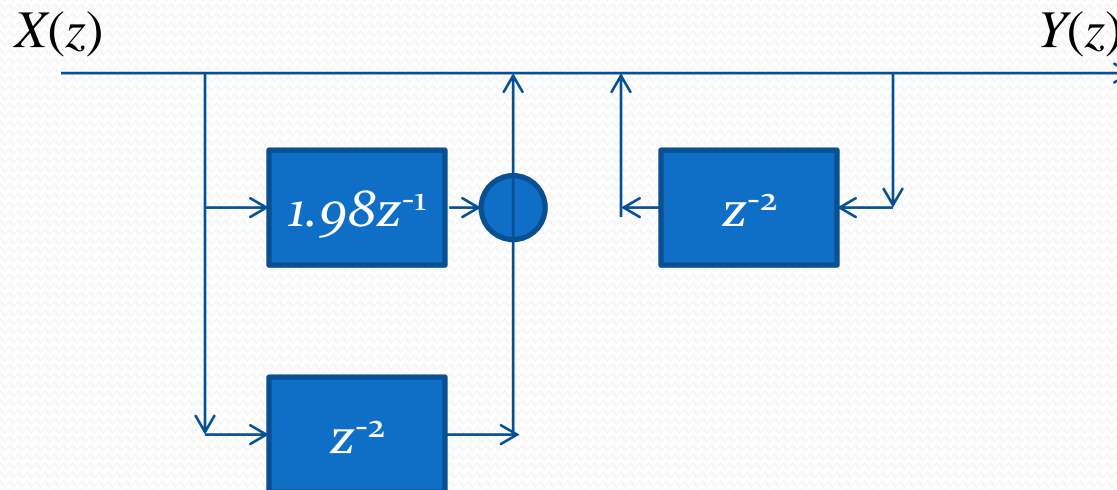
- Lets verify that the spectral component at 60Hz is killed!!!



EKG Example.

- Implementation of this digital filter:

$$H(z) = \frac{z^2 + 1.984z + 1}{1} = \frac{1 + 1.984z^{-1} + z^{-2}}{z^{-2}} = \frac{Y(z)}{X(z)}$$



- Is just a computer program (implemented in C++ or Java)

Evaluación del Modulo.

- Evaluación según ABET

- **Outcome i: Recognition of need for (i.1) and ability to (i.2 DSP) engage in lifelong learning**
 1. (Otho) Que llenen una forma donde conteste preguntas todo lo que aprendió sobre como utilizar la biblioteca y la Internet. También se le puede asignar la búsqueda de artículos que traten sobre temas relativos a la ingeniería como por ejemplos Desastres producidos por la Mala Practica de la Ingeniería o cualquier otro tema.
 2. (Blanca) me va a enviar el piloto que hizo con Rodrigo.
 3. Ver si aprendió a usar herramientas que le van a valer para toda la vida.


Project Document

- A general engineering report must include these chapters:
 - Cover.
 - Contents index.
 - 1. Introduction: (what are you going to do).
 - 2. Problem approach: (how are you going to do, what mathematical approach, equations are you going to use). Lab. Result:s (results of simulation, add block diagrams, figures, explanation of each figure and block).
 - 3. Conclusions: (what you have learned, future work).
 - 4. References: (if you copied, please reference the source).

Project Document

- COVER.
 - Title: Project DSP Module
 - Your Name.
 - Course and section: ee1130-19
 - Trimester: Sp14
 - University.: PUPR
 - Professor: Luis Vicente
 - Date: March 26 2014

Universidad Politécnica de Puerto Rico
Departamento de Ingeniería Eléctrica
Hato Rey



Project Module:
Digital Signal Processing

Your name here
#est. 84810, Section
FA- 2013-09-02
Professor: Luis Vicente Ph.D.

Project Document

- CONTENTS INDEX

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2. Problem Approach -----4.
3. Conclusions-----5.
4. References-----6.

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Project Document

- 1 – INTRODUCTION (three paragraphs)
 - a. Search the web to describe what Signal Processing is about (definition).
 - b. What are the uses of Signal Processing.
 - c. Find out what kind of jobs Signal Processing Engineers will be able to do. How much is the salary

When copy/paste from web, notes, book. Always put references starting with [1]

Project Document

- 2 – PROBLEM APPROACH
 - a. 1st step: define the problem of cleaning an EKG signal corrupted by 60Hz noise.
 - b. Alternative solutions:

| Metodo | Ventajas | Inconvenientes |
|-------------------------------------|-------------------------------------|---|
| Alejarse de la fuente de ruido | Barato, no necesito filtro | A veces uno no puede alejarse de la fuente de ruido. |
| Diseño de filtro mediante Polo/Zero | Es un método conocido que funciona. | Hay que diseñar el filtro y adquirir los componentes. |
| Jaula de Faraday. EMI Rejection | ? | ? |

Project Document

- 2 – PROBLEM APPROACH

- c) Evaluate and select a solution: select Polo/Zero.
- d) Detail the design: (copy and paste the Transfer function equations)

- In our problem the sampling frequency is $f_s=1000/8\text{Hz}$ ($T_s=8/1000$), therefore the zeros of the transfer function must be:

$$z - e^{-j2\pi 60/(1000/8)}$$

$$z + e^{-j2\pi 60/(1000/8)}$$

- The numerator is:

$$\left(z - e^{-j2\pi 60/(1000/8)}\right) * \left(z + e^{-j2\pi 60/(1000/8)}\right)$$

- That creates a numerator of:

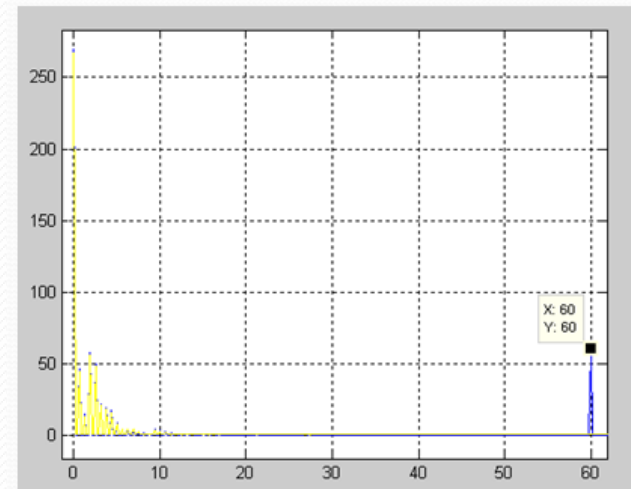
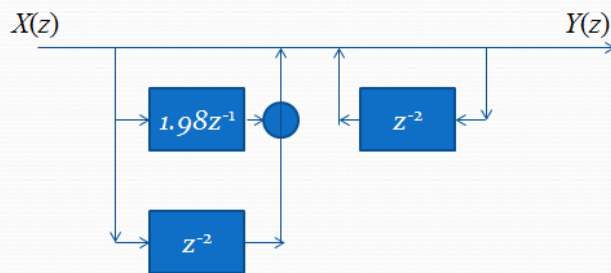
$$z^2 + 1.9842z + 1$$

- We let the denominator to be $z=1$

Project Document

- 2 – PROBLEM APPROACH
 - e) Implementation and testing: (comment each step in your words as best as you can)
 - a. This is the digital filter design example

$$H(z) = \frac{z^2 + 1.9842z + 1}{1} = \frac{1 + 1.9842z^{-1} + z^{-2}}{z^{-2}} = \frac{Y(z)}{X(z)}$$



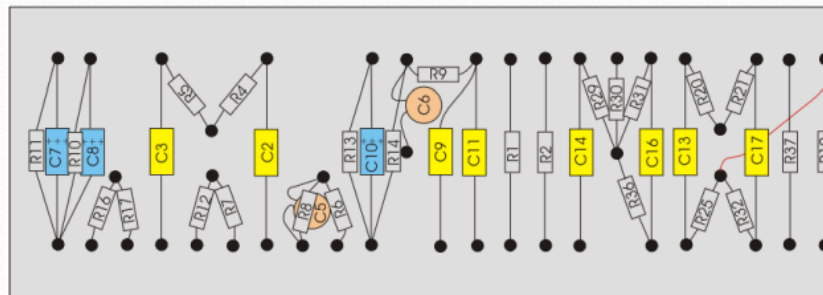
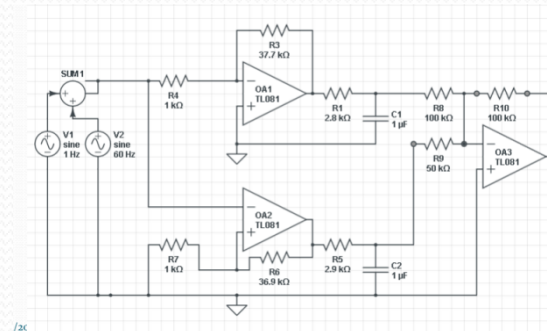
Project Document

- 2 – PROBLEM APPROACH

- e) Implementation and testing: (comment each step in your words as best as you can)

- a. This is the analog filter design example

$$H(s) = \frac{-37.7}{\frac{1}{360}s + 1} + \frac{37.9}{\frac{1}{340}s + 1}$$



Project Document

- 2 – PROBLEM APPROACH
 - f) Performance evaluation: write some paragraph like, «the circuit will be evaluated in the lab, with both simulated and real EKG corrupted by noise... blah blah»
 - g) Presentation and reports: write some paragraph like, «A final report will be written with all performance results and detailed procedure of how to implement and test the circuit»

Project Document

3 – CONCLUSION

Que es lo que usted piensa de este area de la ingeniería y como ha cambiado su opinión al haber visto este modulo.

Project Document

- 4.- References.
 - Must write the references in IEEE format as:
 - [1] Mitra, Sanjit KK, *Digital signal processing: a computer-based approach*, McGraw-Hill Higher Education, 2000.
 - [2] B. Klaus and P. Horn, *Robot Vision*. Cambridge, MA: MIT Press, 1986.
 - [3] L. Vicente. (2013, Apr 28). EE1130-05: Freshman Design for EE and CoE [Online]. Available:
<http://www.lmvicente.com/ee1130.htm>
 - [4] Wikipedia (2014, Jan 13). Digital signal processing [Online]. Available:
http://en.wikipedia.org/wiki/Digital_signal_processing.

Project Document

Sección 19: El proyecto debe ser subido a Blackboard antes de la medianoche del miercoles 10 de septiembre!

De esta manera:

Seccion 09: Enviado por e-mail a lvicente@pupr.edu antes del 20 de octubre 2014. En el subject ponga que es el dsp project y la sección 09.

Grupos de 4 estudiantes aproximadamente. Multidisciplinarios (algunos de EE algunos de CE/CS)

El documento debe tener lo que ustedes quieran por ejemplo:
?????.pdf



End of Class