GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

ECE 2025 Fall 2003

Lab #12: Concept Maps

Date: 19–25 Nov. 2003

You should read the Pre-Lab section of the lab and do all the exercises in the Pre-Lab section before your assigned lab time. You **MUST** complete the online Pre-Post-Lab exercise on Web-CT at the beginning of your scheduled lab session. You can use MATLAB and also consult your lab report or any notes you might have, but you cannot discuss the exercises with any other students. You will have approximately 20 minutes at the beginning of your lab session to complete the online Pre-Post-Lab exercise. The Pre-Post-Lab exercise for this lab includes some questions about concepts from the previous Lab report as well as questions on the Pre-Lab section of this lab.

The Warm-up section of each lab must be completed **during your assigned Lab time** and the steps marked *Instructor Verification* must also be signed off **during the lab time**. After completing the warm-up section, turn in the verification sheet to your TA.

Forgeries and plagiarism are a violation of the honor code and will be referred to the Dean of Students for disciplinary action. You are allowed to discuss lab exercises with other students and you are allowed to consult old lab reports but the submitted work should be original and it should be your own work.

NO lab report is required for this lab. However, there will be a second warm-up for Lab #12 during the week of 1–4 Dec.
This part of Lab #12 will be worth 50 points; the second part of Lab #12 (next week) will also be 50 pts.

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1 Concept Maps

The human brain processes information that it receives from various senses and tries to organize it and make meaning out of it. In the case of vision, the brain's task is simplified if information is presented in a graphical format rather than in a textual format. Concept maps are a method of visualizing the relationships among bits of information. In a concept map, information is presented in a very structured graphical format that is easy for the brain to interpret as useful information.

1.1 What are Concept Maps?

Concepts can be defined as a perceived regularity in events or objects, or records of events or objects, designated by a label. Propositions are statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected with other words to form a meaningful statement.

Concept maps consist of various concepts that are linked together to generate propositions. A proposition is usually a semantic unit (a unit of meaning). A simple concept map is shown in Fig. 1. The concepts, "Mammals", "Dogs", "Cats", "Mice" and "Milk" are enclosed in circles or boxes. The linking words "Could be", "chase", "eat" and "drink" connect concepts together to create propositions. Thus Fig. 1 displays the following propositions:

- Mammals could be dogs.
- Mammals could be cats.
- Mammals could be mice.
- Dogs chase cats.
- Cats eat mice.
- Cats drink milk.

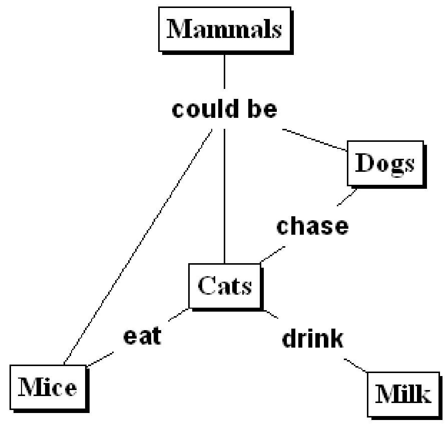

Figure 1: Sample Concept Map

1.2 Creating Concept Maps

The following guidelines should be followed while generating concept maps.

- Concept maps should be created in a hierarchical fashion with the more general concepts at the top and the more specific concepts near the bottom.
- Cross-links can be used when concepts have multiple links.
- Linking words used should be precise.
- Concept maps should be created such that propositions can be understood independent of one another. An example of a bad map is shown in Fig. 2(a). In Fig. 2(a), the propositions "Wood for fire" and

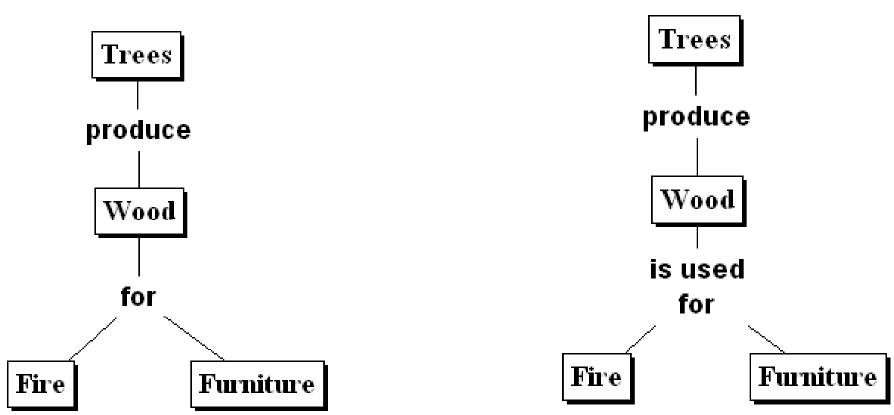

Figure 2: (a) Propositions that are not independent of one another. (b) Independent Propositions.

"Wood for furniture" make no sense by themselves. This map has been designed to be read as "Trees produce wood for fire" and "Trees produce wood for furniture". A better map is shown in Fig. 2(b).

- Avoid using sentences in boxes to represent concepts. Instead, break the sentence down to generate a new subsection in the map. The words that sit in a box should represent only one concept.
- Avoid string maps. These represent poor map construction skills and poor grasp of the material since there are no cross links. A sample string map is shown in Fig. 3.

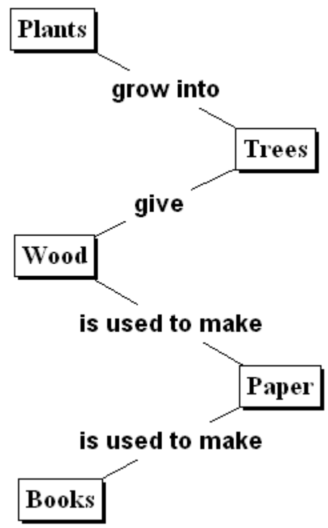

Figure 3: A String Map shows poor grasp of the concepts.

2 PreLab: Software Used

2.1 Conceptor

Concept maps in ECE-2025 have been created using the ***Conceptor*** Concept Map Software.[1] This software allows the user to create concept maps with ease and when a concept map is complete, it can be exported to XML. This XML code can be opened in ***Conceptor*** for the purpose of editing or viewing the map. A screenshot of ***Conceptor*** is shown in Fig. 4. ***Conceptor*** can be downloaded from

`http://dml-wpm.ece.gatech.edu/cnt.exe.`

A web based version is available at `http://awarehome.ece.gatech.edu/extra/cnt.html.`

On running the software, one can see three tabs at the top left. The `Workspace` is where concept maps can be created and modified. The `Preview` window displays the current map in a printer friendly format. `Options` allows one to set various options such as fonts, colors and meta information. At the top right of the workspace sits a toolbar. Various buttons in the toolbar allow one to open maps, create new maps, save maps, zoom in or out of maps, move maps and generate XML code. Using these functions one can easily create and modify concept maps. The options menu allows the user to change the appearance of the concept map as well as enter important meta information. ***Conceptor*** will not let you save your concept maps unless all the meta information has been entered. Nodes and links can be modified by changing their colors and their skins. Currently two skins are available; `Default` and `Clarity,` shown in Fig. 5. Both skins have their advantages and disadvantages. The Clarity skin shows just the concept name and thus the information carried by the node has a strong impact on the user. However, in order to modify any attributes of the node or link it to other nodes, the user needs to navigate through the menu by clicking the button to the top left of the node. The Default skin has shortcuts in the body of the node for modifying the concept name and linking the node to other nodes. Thus the Default skin is more user friendly when constructing the map.

2.1.1 Adding Resources to Concepts

With ***Conceptor*** it is also possible to add various resources (such as pictures, movies, .pdf files, other concept maps, etc.) to each concept. The addition of resources to concept maps could become very tedious. The maps that we are creating are based on concepts in *SP First.* Thus, concepts throughout the book are

[1] Authored by Chris Scheibe of Georgia Tech, using Macromedia Flash.

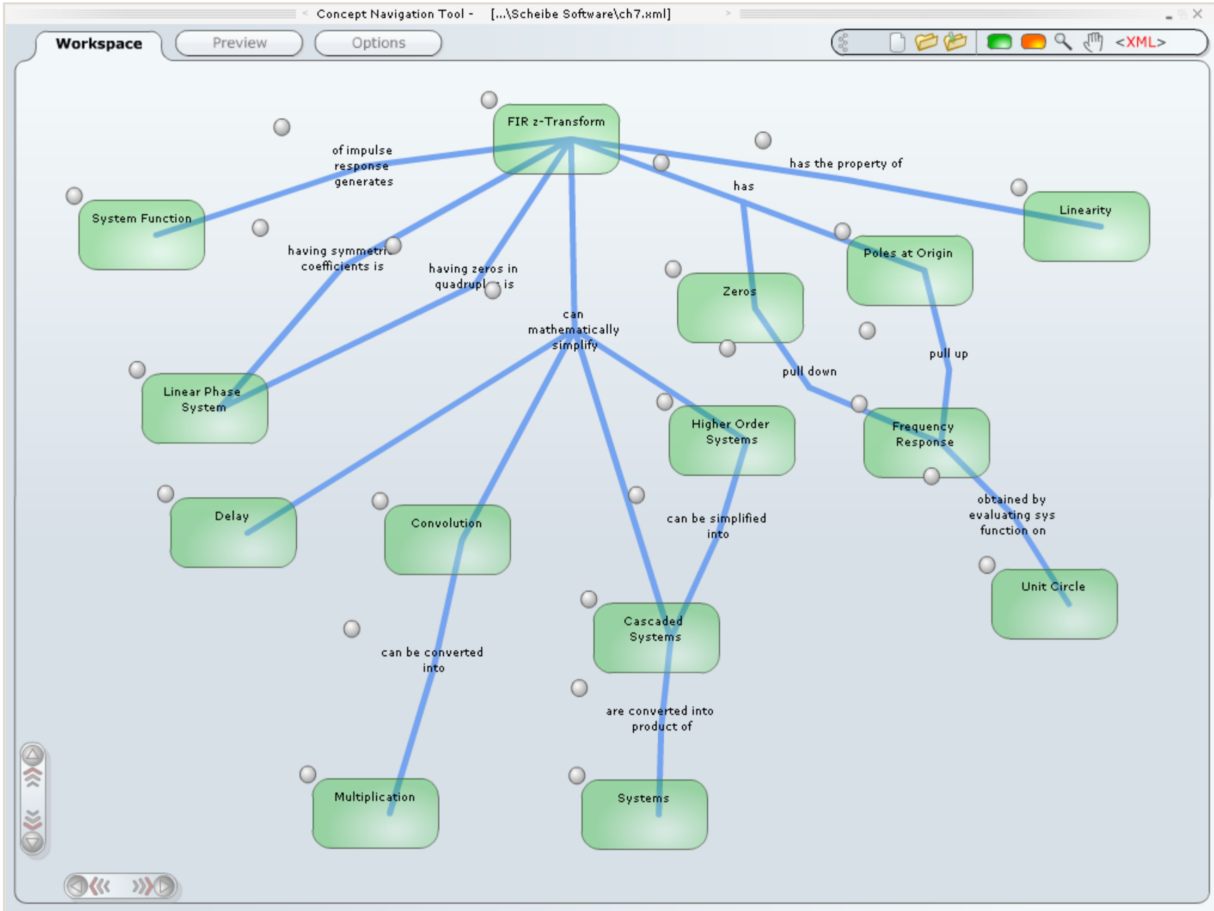

Figure 4: The ***Conceptor*** Concept Map Software

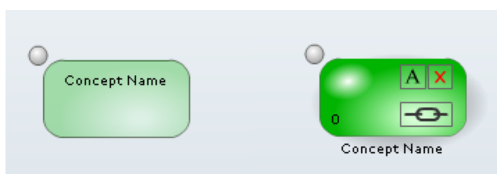

Figure 5: Node Skins: Clarity (Left) and Default (Right).

interrelated and related resources appear in various locations throughout the book. It would be humanly impossible to be able to read through the whole book and add relevant resources to each concept. ***Conceptor*** solves this problem of adding resources. Each concept in a map has two fields associated with it. The first field holds the concept name that is displayed on the map in the viewer. The second field contains a list of keywords. Once a concept is created and keywords are entered, ***Conceptor*** searches through a database of resources (such as homework solutions, test solutions, lecture videos, etc.) and those resources that have matching keywords are automatically added to the concept. This eliminates the tedious process of manually adding resources. All the map creator has to do is include the relevant keywords in each node of the map, and then the resources will be automatically added.

2.2 PeZ: Introduction

In order to build an intuitive understanding of the relationship between the location of poles and zeros in the z-domain, the impulse response $h[n]$ in the n-domain, and the frequency response $H(e^{j\hat{\omega}})$ (the $\hat{\omega}$-domain), A graphical user interface (GUI) called **PeZ** was written in MATLAB for doing interactive explorations of the three domains.[2] **PeZ** is based on the system function, represented as a ratio of polynomials in z^{-1}, which can be expressed in either factored or expanded form as:

$$H(z) = \frac{B(z)}{A(z)} = G\frac{\prod_{k=1}^{M}(1 - z_k z^{-1})}{\prod_{\ell=1}^{N}(1 - p_\ell z^{-1})} = \frac{\sum_{k=0}^{M} b_k z^{-k}}{1 - \sum_{\ell=1}^{N} a_\ell z^{-\ell}} \quad (1)$$

There are two version of the **PeZ** GUI: the original one written for versions 4 and 5 of MATLAB; and a newer one for version 6. Both versions are contained in the *SP-First* toolbox. To run **PeZ**, type `pezdemo` at the command prompt and you will see the GUI shown in Fig. 6.[3]

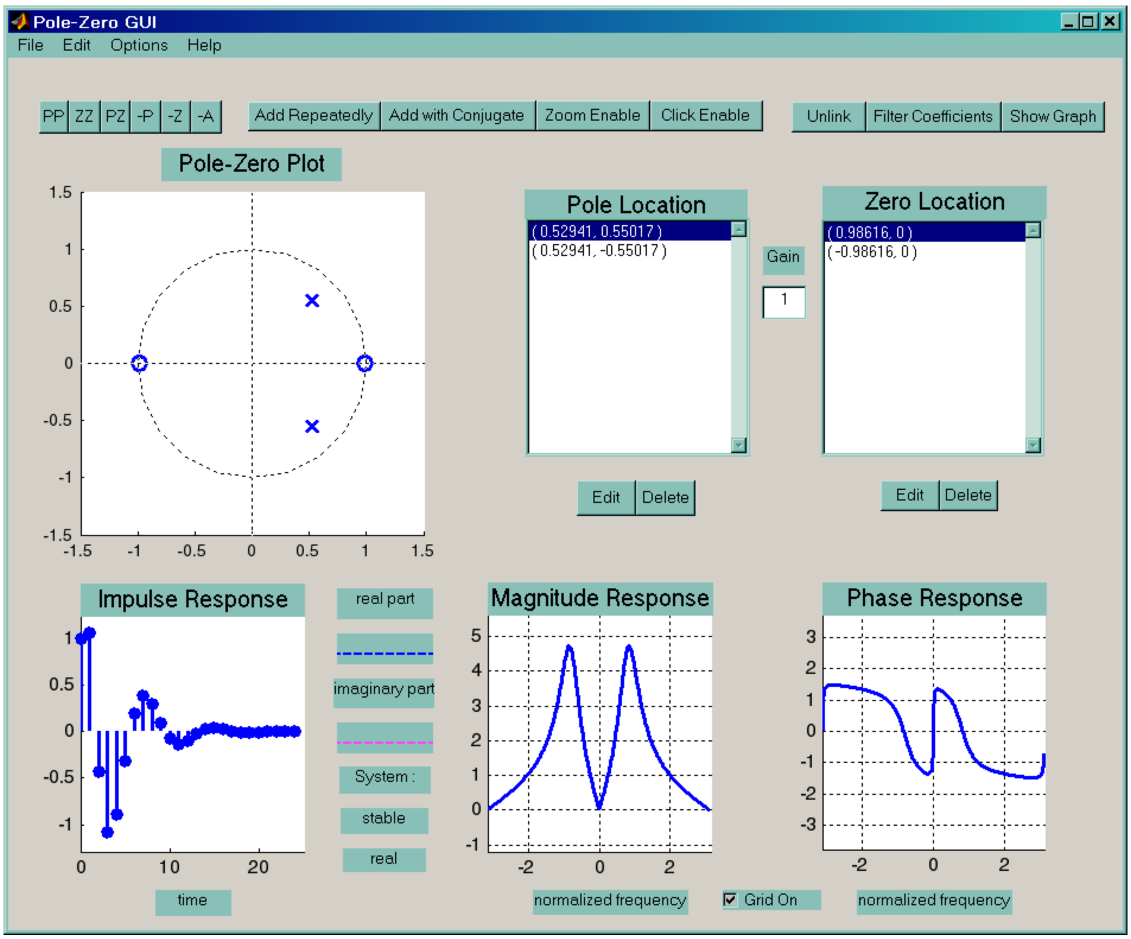

Figure 6: GUI interface for `pezdemo` running in MATLAB version 6. A 2nd-order bandpass filter is shown. Pole and zero locations are given in rectangular coordinates.

2.2.1 Controls for PeZ using `pezdemo`

The **PeZ** GUI is controlled by the `Pole-Zero Plot` where the user can add (or delete) poles and zeros, as well as move them around with the pointing device. For example, Fig. 6 shows a case where two (complex-conjugate) poles have been added, along with single zeros at $z = 1$ and $z = -1$. The buttons named `PP` and

[2]The original **PeZ** was written by Craig Ulmer; a later version by Koon Kong is the one that we will use in this lab.

[3]The command `pez` will invoke the older version of **PeZ** which is distinguished by a black background in all the plot regions.

`ZZ` were used to add these poles and zeros. By default, the `Add with Conjugate` property is turned on, so poles and zeros are typically added in pairs to satisfy the complex-conjugate property:

A polynomial with real coefficients has roots that are real, or occur in complex-conjugate pairs.

To learn about the other controls in `pezdemo`, access the menu item called "Help" for extensive information about all the **PeZ** controls and menus.

Here are a few things to try. You can use the `Pole-Zero Plot` to selectively place poles and zeros in the z-plane, and then observe (in the other plots) how their placement affects the impulse and frequency responses. In **PeZ** an individual pole/zero pair can be moved around and the corresponding $H(e^{j\hat{\omega}})$ and $h[n]$ plots will be updated as you drag the pole (or zero). Since exact placement of poles and zeros with the mouse is difficult, an `Edit` button is provided for numerical entry of the real and imaginary parts. Before you can edit a pole or zero, however, you must first select it in the list of `Pole Locations` or `Zero Locations`. Removal of individual poles or zeros can also be performed by using the `-P` or `-Z` buttons, or with the `Delete` button. Note that all poles and/or zeros can be easily cleared by clicking on the `-A` button.

2.2.2 Create an IIR Filter with PeZ

Play around with **PeZ** for a few minutes to gain some familiarity with the interface. Implement the following first-order system:

$$H(z) = \frac{1 - z^{-1}}{1 + 0.9z^{-1}}$$

by placing its pole and zero at the correct locations in the z-plane. First try placing the pole and zero with the mouse, and then use the `Edit` feature to get exact locations. Since **PeZ** wants to add complex-conjugate pairs, you might have to delete one of the poles/zeros that were added; or you can turn off the `Add with Conjugate` feature. Look at the frequency response and determine what kind of filter you have.

Now, use the mouse to "grab" the pole and move it from $z = -0.9$ to $z = +0.8$. Observe how the frequency response changes. Describe the type of filter that you have created.

3 Warm-up

3.1 Exercise 1: Building a Concept Map

Open up the file `exercise1.png` shown in Fig. 7. In this exercise, you will have to create this concept map using the ***Conceptor*** software. To run the software navigate to the directory where you downloaded the ***Conceptor*** application and "double-click" on `cnt.exe` The next few steps will guide you in creating the required Concept Map.

(a) First, we will set up some Options that control the way the Concept Map looks. To do this,

  (i) Click on the `Options` tab

  (ii) Click on the button that says `Nodes` to set the node attributes. In particular, choose the `Clarity` skin for Nodes.

  (iii) Click the button that says `Links` and similarly choose the `Clarity` skin for Links.

(b) Next step is to place the individual Concept (Nodes) and create appropriate links between them as shown in Fig. 7. To do this,

  (i) Click on the `Workspace` tab. To allow you to create a concept map, a toolbar is provided at the top right. The toolbar is shown in Fig. 8.

  (ii) Placing the pointer over the little green box in the toolbar, you will see a bubble that reads `New Node...`

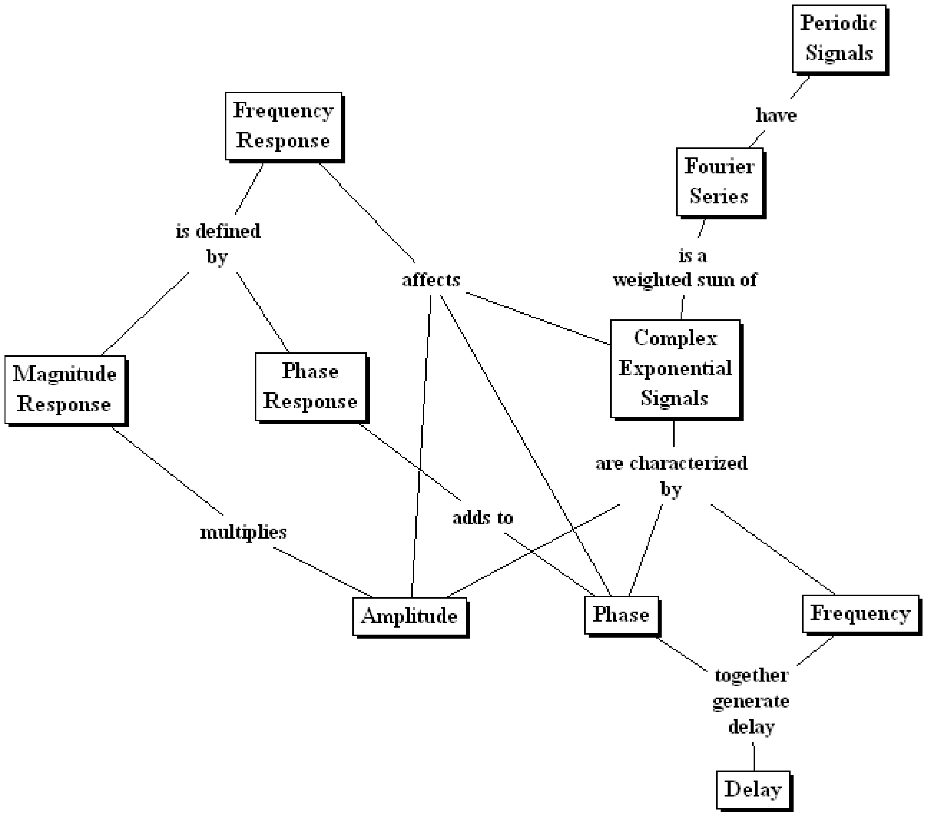

Figure 7: Map to be created in Exercise 1.

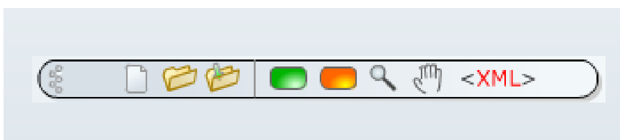

Figure 8: Toolbar.

(iii) Placing the pointer over the orange box will read `New Link...`

(iv) Placing the pointer over the Lens will read `Zoom` and this can be used to Zoom in or out on the Concept Map once you have populated it with more concepts. These buttons will be used to add concept nodes and links to concept maps.

(c) To place a Node, click on the green box in the toolbar and drag the pointer to a point in the workspace. You should see a green block move with the pointer. If the node is the first concept node that you are going to add, then place it at the top center of the screen. Any node can be moved around by clicking on it and dragging it, holding the mouse button and dragging it to the desired location.

(d) The Round Grey button to the left of the Node (or Link) is the Menu button. Click on it to see available options. Use this to Delete or Move a Node and to add text as shown in the next step. Menu options are shown in Fig. 9.

(e) This first node will correspond to the *Frequency Response* concept shown in Fig. 7. In order to add text to the node, click the menu button to the top left of the node. Clicking it again will close the menu. Choose `Keywords` from the menu. An `Input` window opens up. Under `Concept Name,` type in `Frequency Response.` This is the text that will be displayed on the screen. The text that

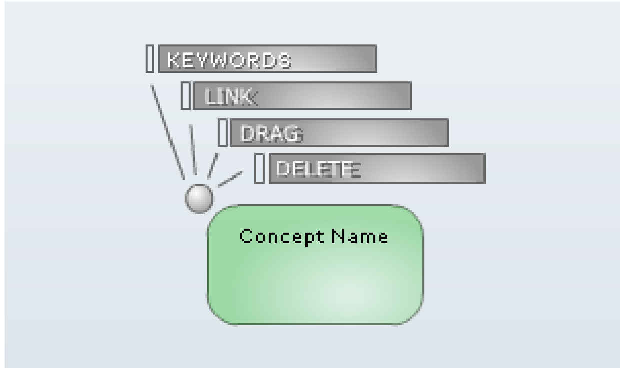

Figure 9: Menu.

you enter under `Keywords` will be used to search through a database for relevant resources. This feature is not applicable for the current lab. You may leave this field as it is. Click `OK.` You should see the concept name *Frequency Response* appear in the node.

(f) Similarly, add the concept *Complex Exponential Signals* and place it in the workspace corresponding to a location as shown in Fig. 7.

(g) Now you need to add a link between these concepts. In the toolbar, click on the orange box to add a new link. Place this link in between the two nodes.

(h) In order to add text, click the grey menu button to the top left of the link to open the menu and click `Association.` In the `Input` window that opens up, type `affects` under `Associations,` and click `OK.` Now you have two concepts and a linking term ready.

(i) You now need to physically connect these together using linking lines. In order to connect the concept *Frequency Response* with the link `affects,` open the menu for the *Frequency Response* node and click on `Link.` All candidates for linking will light up. Click on the link `affects.` You will see a line connecting the two together.

(j) In order to connect the link `affects` to the node *Complex Exponential Signals*, open the menu for the `affects` link and click `Link.` Once again, all candidates for linking will light up. Click on the *Complex Exponential Signals* node and you will see a line connecting the two.

(k) Once you have done this, you will have an incomplete Concept Map similar to Fig. 10.

(l) Note: if you connect a line to the incorrect object, then the line can be removed by reconnecting the same two objects.

(m) Go back to the options menu and set the skin to Default for nodes and links. Click back on the Workspace. You will observe that the skins have changed. The default skin is more user friendly since all the menu options are displayed in the body of the nodes and links. However, using the Default skin would lead to the map being cluttered and the information in the map has a low impact. You may choose to continue working with whichever skin you prefer.

Now that you have created a small part of the concept map, populate the remaining portion of the concept map to create the entire map in Fig. 7. Use the zoom and scroll controls if the map gets larger than the screen display.

(n) When you are done, you need to save the concept map that you have created. ***Conceptor*** will not allow you to save unless all the meta information has been filled in.

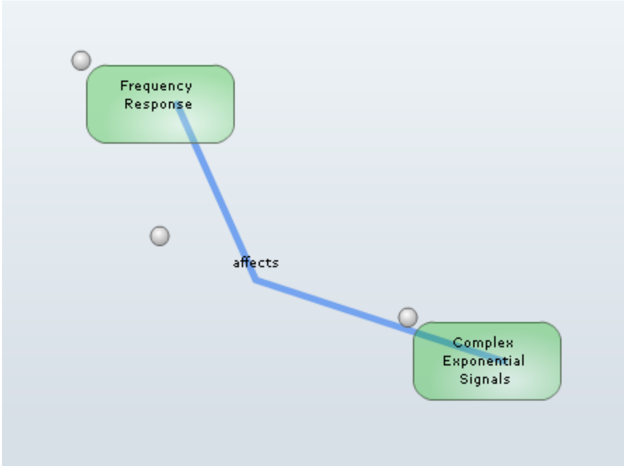

Figure 10: Incomplete Concept Map.

(i) Click on `Options` and click on the `Global` button.

(ii) Under `Name`, enter your name. Under `Lecture`, enter `Concept Map Lab 1`. Under `Class`, enter `ECE2025`. Finally enter today's date.

(iii) Now click on the `Workspace` tab and click on the `Save File...` button in the `Toolbar` (Fig. 8) to save the Concept Map that you have just created.

(iv) Click `Preview` to display the map in a printer friendly format.

Print a copy of your map by printing out a screen capture and hand it to the TA.

Instructor Verification (separate page)

3.2 Exercise 2: Interpreting a Concept Map

Based on the concept map that you have just created, answer the following questions:

(a) How are complex exponential signals characterized?

(b) How does the Magnitude Response affect the amplitude of an output signal?

(c) What is the effect of the Phase Response on an output signal?

(d) Does the Frequency Response affect the frequency of an output signal?

(e) What are Fourier Series Coefficients?

(f) What type of signals have a Fourier Series representation?

Write your answers on the Instructor Verification Sheet.

Instructor Verification (separate page)

3.3 Exercise 3: Quick Recall of Concepts

For each concept in the following list, write down the first 5 or 6 related concepts that come to mind. Quick reaction time is required. Remember that a concept is defined by a single term or a few terms; not sentences. There is no single correct answer for this exercise; it is just a sampling of your cognitive state when thinking about signal processing.

(a) Frequency Response

(b) Impulse Response

(c) IIR

(d) Poles

Enter your lists directly into WebCT[4] and also write your responses on the Instructor Verification Sheet.

Instructor Verification (separate page)

3.4 Relationships between z, n, and $\hat{\omega}$ domains

The lab verification requires that you write down your observations on the verification sheet when using the PeZ GUI. These written observations will be graded.

Work through the following exercises and keep track of your observations by filling in the worksheet at the end of this assignment. In general, you want to make note of the following quantities:

- How does $h[n]$ change with respect to its rate of decay? For example, when $h[n] = a^n u[n]$, the impulse response will fall off more rapidly when a is smaller.
- If $h[n]$ exhibits an oscillating component, what is the period of oscillation? Also, estimate the decay rate of the "envelope" that overlays the oscillation.
- How does $H(e^{j\hat{\omega}})$ change with respect to peak location and peak width?

Note: review the "Three-Domains - FIR" under the Demos link for chapter 7 and "Three-Domains - IIR" under the Demos link for chapter 8 for movies and examples of these relationships.

3.4.1 Real Poles

(a) Use **PeZ** to place a single pole at $z = \frac{1}{2}$. You may have to use the `Edit` button to get the location exactly right. Use the plots in **PeZ** for this case as the reference for answering the next five parts.

(b) Move the pole close to the origin (still on the real axis). You can do this by dragging the pole to the new location. Describe the changes in the impulse response $h[n]$ and the frequency response $H(e^{j\hat{\omega}})$.

(c) When you move poles and zeros, the impulse response and frequency response plots are updated continually in **PeZ**. Select the pole you want to move and start to drag it slowly. Watch for the update of the plots in the secondary window.

Move the real pole slowly from $z = \frac{1}{2}$ to $z = 1$ and observe the changes in the impulse response $h[n]$ and the frequency response $H(e^{j\hat{\omega}})$.

(d) Place the pole exactly on the unit circle (or maybe just inside at a radius of 0.99999999). Describe the changes in $h[n]$ and $H(e^{j\hat{\omega}})$. What do you expect to see for $H(e^{j\hat{\omega}})$?

(e) Move the pole outside the unit circle. Describe the changes in $h[n]$. Explain how the appearance of $h[n]$ validates the statement that the system is not stable. In this case, the frequency response $H(e^{j\hat{\omega}})$ is not legitimate because the system is no longer stable.

(f) In general, where should poles be placed to guarantee system stability? By stability we mean that the system's output does not blow up.

Instructor Verification (separate page)

[4] A WebCT "quiz" has been set up so that you can enter your lists directly into WebCT. Make sure that you show this to your TA for verification.

Lab #12
ECE-2025
Fall-2003
WORKSHEET & VERIFICATION PAGE

For each verification, be prepared to explain your answer and respond to other related questions that the lab TA's or professors might ask. Turn this page in at the end of your lab period.

Name: ________________________________ Date of Lab: __________

Part 3.1 Construct the given concept map. Print a copy for your TA.

Verified:____________________ Date/Time:__________

Part 3.2 Write your interpretation of the concept map.

(a)

(b)

(c)

(d)

(e)

(f)

Verified:____________________ Date/Time:__________

Part 3.3 Quick recall of concepts:

(a) Frequency Response

(b) Impulse Response

(c) IIR

(d) Poles

Verified:______________________ Date/Time:____________

Part	Observations
3.4.1(a)	$h[n]$ decays exponentially with no oscillations, $H(e^{j\hat{\omega}})$ has a hump at $\hat{\omega} = 0$
3.4.1(b)	
3.4.1(c)	
3.4.1(d)	
3.4.1(e)	
3.4.1(f)	

Verified:______________________ Date/Time:____________