Task Breakdown

1. Z-Plane Plot:

- Create a visual plot of the z-plane, including the unit circle.
- Allow users to:
    - Place zeros and poles by clicking on the plot.
    - Drag zeros and poles to adjust their positions.
    - Delete zeros or poles by clicking on them.
    - Clear all zeros, poles, or both using buttons.
    - Optionally add conjugates for complex elements using a checkbox.

2. Frequency Response Plot:

- Generate a plot displaying the frequency response of the designed filter.
- Include separate graphs for magnitude response and phase response.

3. Filter Application:

- Enable users to apply the designed filter to a lengthy signal (minimum 10,000 points).
- Simulate real-time filtering:
    - Display a graph of the signal's time progress, revealing only a portion at a time.
    - Display a graph of the filtered signal's time progress as filtering occurs.
    - Provide a slider to control the filtering speed/temporal resolution (e.g., 1-100 points per second).
- Allow users to input a real-time signal by moving the mouse within a designated area:
    - Map mouse coordinates (x or y) to the input signal.
    - Reflect mouse speed in signal frequency (faster motion generates higher frequencies).

4. All-Pass Filter Features:

- Implement a library of all-pass filters:
    - Display zero-pole combinations and phase responses for each filter.
    - Allow users to select and add filters to the original design.
- Provide a custom all-pass filter option:
    - Enable users to specify a custom "a" value.
    - Calculate and integrate the corresponding phase response into the library.
- Allow users to enable/disable added all-pass filters using a drop-down menu or checkboxes.

The UI for designing the all-pass filter can have two main sections:

1. All-Pass Filter Library:

- List of predefined filters:
  - Each filter is listed with a descriptive name or identifier.
  - Clickable thumbnails showing the zero-pole plot of each filter.
  - Hovering over a thumbnail displays the corresponding phase response in a tooltip or overlay.
  - Clicking on a thumbnail selects the filter for adding to the current design.
- Filter details panel:
  - Once a filter is selected, this panel displays detailed information:
    - Transfer function equation or difference equation representation.
    - Numerical values of specific parameters like "a" coefficient.
    - Larger plot of the zero-pole configuration and phase response.
    - Optional: Frequency response plot demonstrating the filter's effect on magnitude and phase.
- Search and filter options:
  - Allow users to search for specific filters by name or keyword.
  - Provide filters based on desired phase response characteristics (e.g., linear, minimum delay).

2. Custom All-Pass Filter:

- "a" coefficient input:
  - A text field or slider where users can input the desired "a" value.
  - Real-time update of the phase response based on the entered value.
- Visualization panels:
  - Update the zero-pole plot and phase response based on the custom "a" value.
  - Optionally show the frequency response of the custom filter.
- Add to Design button:
  - Once the user is satisfied with the custom filter, they can click a button to add it to the current design alongside the pre-defined filters.

3. Additional UI elements:

- Enable/disable checkboxes: For each added all-pass filter, provide a checkbox to easily enable or disable its effect on the overall filter response.
- Information panel: Briefly explain the concept of all-pass filters and their role in correcting phase shifts.
- Help button: Link to a more detailed explanation of all-pass filters and their design considerations.
- By combining these elements, you can create a user-friendly UI for designing and incorporating all-pass filters into your Z-plane filter application. Remember to keep

the interface intuitive, visually appealing, and informative to empower users of all skill levels to leverage the power of all-pass filters.