(a) Since there is a pole at \( z = 1 \), the ROC does not include the unit circle. This means the system is not stable.

(b) Since \( h[n] \) is causal and IIR, it cannot be symmetric, and thus cannot have linear phase.

(c) Since \( H(z) \) has poles, we know \( h[n] \) is IIR.

Since the impulse response is real, the poles and zeros must be in conjugate pairs. The remaining 2 zeros are at zero (the number of poles always equals the number of zeros).

Resonance at \( \infty = \Re \) pole inside unit circle here.

\[
20 \log_{10} |H(e^{j2\pi f})| = -\infty \quad \text{zero at } e^{j2\pi f}
\]

\[
20 \log_{10} |H(e^{j2\pi f})| = \infty \quad \text{pole at } e^{j2\pi f}
\]
5.38. (a) The causal systems have conjugate zero pairs inside or outside the unit circle. Therefore

\[ H(z) = (1 - 0.9e^{j0.8\pi}z^{-1})(1 - 0.9e^{-j0.8\pi}z^{-1})(1 - 1.25e^{j0.8\pi}z^{-1})(1 - 1.25e^{-j0.8\pi}z^{-1}) \]

\[ H_1(z) = (0.9)^2(1 - 10/9)e^{j0.8\pi}z^{-1})(1 - (10/9)e^{-j0.8\pi}z^{-1}) \]
\[ (1 - 0.8e^{j0.8\pi}z^{-1})(1 - 0.8e^{-j0.8\pi}z^{-1}) \]

\[ H_2(z) = (0.9)^2(1 - 10/9)e^{j0.8\pi}z^{-1})(1 - (10/9)e^{-j0.8\pi}z^{-1})(1 - 1.25e^{j0.8\pi}z^{-1}) \]
\[ (1 - 1.25e^{-j0.8\pi}z^{-1}) \]

\[ H_3(z) = (1.25)^2(1 - 0.9e^{j0.8\pi}z^{-1})(1 - 0.9e^{-j0.8\pi}z^{-1})(1 - 0.8e^{j0.8\pi}z^{-1}) \]
\[ (1 - 0.8e^{-j0.8\pi}z^{-1}) \]

\( H_3(z) \) has all its zeros outside the unit circle, and is a maximum phase sequence. \( H_3(z) \) has all its zeros inside the unit circle, and thus is a minimum phase sequence.

(b)

\[ H(z) = 1 + 2.5788z^{-1} + 3.4975z^{-2} + 2.5074z^{-3} + 1.2656z^{-4} \]

\[ h[n] = \delta[n] + 2.5788\delta[n-1] + 3.4975\delta[n-2] + 2.5074\delta[n-3] + 1.2656\delta[n-4] \]

\[ H_1(z) = 1.2656 + 2.5074z^{-1} + 3.4975z^{-2} + 2.5788z^{-3} + 0.81z^{-4} \]

\[ h_1[n] = 1.2656\delta[n] + 2.5788\delta[n-1] + 3.4975\delta[n-2] + 2.5074\delta[n-3] + 0.81\delta[n-4] \]

\[ H_2(z) = 0.81 + 2.5074z^{-1} + 3.4975z^{-2} + 2.5788z^{-3} + 1.5625z^{-4} \]

\[ h_2[n] = 0.81\delta[n] + 2.1945\delta[n-1] + 3.3906\delta[n-2] + 2.8917\delta[n-3] + 1.5625\delta[n-4] \]

\[ H_3(z) = 1.5625 + 2.8917z^{-1} + 3.3906z^{-2} + 2.1945z^{-3} + 0.81z^{-4} \]

\[ h_3[n] = 1.5625\delta[n] + 2.8917\delta[n-1] + 3.3906\delta[n-2] + 2.1945\delta[n-3] + 0.81\delta[n-4] \]

<table>
<thead>
<tr>
<th>n</th>
<th>E(n)</th>
<th>E_1(n)</th>
<th>E_2(n)</th>
<th>E_3(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.0</td>
<td>1.6</td>
<td>0.7</td>
<td>2.4</td>
</tr>
<tr>
<td>1</td>
<td>7.7</td>
<td>7.9</td>
<td>5.5</td>
<td>10.8</td>
</tr>
<tr>
<td>2</td>
<td>19.9</td>
<td>20.1</td>
<td>17.0</td>
<td>22.3</td>
</tr>
<tr>
<td>3</td>
<td>26.2</td>
<td>26.8</td>
<td>25.3</td>
<td>27.1</td>
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<tr>
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<td>27.8</td>
<td>27.8</td>
<td>27.8</td>
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<tr>
<td>5</td>
<td>27.8</td>
<td>27.8</td>
<td>27.8</td>
<td>27.8</td>
</tr>
</tbody>
</table>

The plot of \( E_3[n] \) corresponds to the minimum phase sequence.
Inverse systems are on the unit circle. Stable inverse does not exist.

The zeros occur in conjugate reciprocal pairs, so this is a zero phase system. Since the poles of the system are both inside and outside the unit circle, the inverse is stable and causal. Therefore, the inverse exists.

Therefore, the inverse is both stable and causal.

Since the poles are not conjugate reciprocal pairs, this does not have zero or generalized linear phase. H(z) has a pole at z = 0 and perhaps z = co. Therefore, the ROC is 0 < |z| < co.

The poles are not in conjugate reciprocal pairs, so this does not have zero or generalized linear phase.

A stable system's ROC includes the unit circle.

Linear phase systems are zero phase systems with additional poles or zeros at z = 0, co, or 1.
5.42. (a)

\[ A(e^{j\omega}) = 1, \quad |\omega| < \pi \]
\[ \phi(\omega) = -\alpha \omega, \quad |\omega| < \pi \]

(b)

\[ h[n] = \frac{1}{2\pi} \int_{-\pi}^{\pi} e^{-j\omega n} e^{j\alpha \omega} d\omega = \frac{\sin \pi(n - \alpha)}{\pi(n - \alpha)} \]

(c) If \( \alpha \) is an integer, then \( h[n] \) is symmetric about the point \( n = \alpha \). If \( \alpha = \frac{M}{2} \), where \( M \) is odd, then \( h[n] \) is symmetric about \( \frac{M}{2} \), which is not a point of the sequence. For \( \alpha \) in general, \( h[n] \) will not be symmetric.
5.57. (a) 

\[ x[n] = s[n] \cos \omega_0 n = \frac{1}{2} s[n] e^{j\omega_0 n} + \frac{1}{2} s[n] e^{-j\omega_0 n} \]

\[ X(e^{j\omega}) = \frac{1}{2} S(e^{j(\omega - \omega_0)}) + \frac{1}{2} S(e^{j(\omega + \omega_0)}) \]

\[ Y(e^{j\omega}) = H(e^{j\omega}) X(e^{j\omega}) = \frac{1}{2} e^{-j\phi_0} S(e^{j(\omega - \omega_0)}) + \frac{1}{2} e^{j\phi_0} S(e^{j(\omega + \omega_0)}) \]

\[ y[n] = \frac{1}{2} s[n] e^{j(\omega_0 n - \phi_0)} + \frac{1}{2} s[n] e^{-j(\omega_0 n - \phi_0)} \]

\[ = s[n] \cos(\omega_0 n - \phi_0) \]

(b) This time,

\[ Y(e^{j\omega}) = H(e^{j\omega}) X(e^{j\omega}) = \frac{1}{2} e^{-j\phi_0} e^{-j\omega n_d} S(e^{j(\omega - \omega_0)}) + \frac{1}{2} e^{j\phi_0} e^{j\omega n_d} S(e^{j(\omega + \omega_0)}) \]

\[ y[n] = \delta[n - n_d] * \left( \frac{1}{2} s[n] e^{j(\omega_0 n - \phi_0)} + \frac{1}{2} s[n] e^{-j(\omega_0 n - \phi_0)} \right) \]

\[ = \delta[n - n_d] * s[n] \cos(\omega_0 n - \phi_0) \]

\[ = s[n - n_d] \cos(\omega_0 n - \omega_0 n_d - \phi_0) \]

Therefore, if \( \phi_1 = \phi_0 + \omega_0 n_d \) then

\[ y[n] = s[n - n_d] \cos(\omega_0 n - \phi_1) \]

for narrowband \( s[n] \).

(c) 

\[ \tau_{gr} = -\frac{d}{d\omega} \arg[H(e^{j\omega})] = -\frac{d}{d\omega} [-\phi_0 - \omega n_d] = n_d \]

\[ \tau_{ph} = -\frac{1}{\omega} \arg[H(e^{j\omega})] = -\frac{1}{\omega} [-\phi_0 - \omega n_d] = \frac{\phi_0}{\omega} - n_d \]

\[ y[n] = s[n - \tau_{gr}(\omega_0)] \cos(\omega_0 (n - \tau_{ph}(\omega_0))) \]

(d) The effect would be the same as the following:

(i) Bandlimit interpolate the composite signal to a C-T signal with some rate \( T \).

(ii) Delay the envelope by \( T \cdot \tau_{gr} \), and delay the carrier by \( T \cdot \tau_{ph} \).

(iii) Sample to a D-T signal at rate \( T \).