tiators.

$H(e^{j\omega}) = \overline{H}(e^{j\omega})\, e^{j\theta(\omega)} \rightarrow (6.25)$

**Example 6.1** Determine the frequency response of FIR filter defined by $y(n) = 0.25x(n) + x(n-1) + 0.25x(n-2)$. Calculate the phase delay and group delay.

**Solution**

Given

$$y(n) = 0.25x(n) + x(n-1) + 0.25x(n-2)$$

Taking Fourier transform on both sides

$$Y(e^{j\omega}) = 0.25X(e^{j\omega}) + e^{-j\omega}X(e^{j\omega}) + 0.25e^{-2j\omega}X(e^{j\omega})$$

$$H(e^{j\omega}) = \frac{Y(e^{j\omega})}{X(e^{j\omega})} = 0.25 + e^{-j\omega} + 0.25e^{-2j\omega}$$

$$= e^{-j\omega}\left(0.25e^{j\omega} + 1 + 0.25e^{-j\omega}\right) = e^{-j\omega}(1 + 0.5\cos\omega)$$

$$= e^{-j\omega}\overline{H}(e^{j\omega}) \qquad \text{(6.41a)}$$

Comparing Eq. (6.41a) with Eq. (6.25) we get $\theta(\omega) = -\omega$.

The phase delay $\tau_p = \dfrac{-\theta(\omega)}{\omega} = \dfrac{\omega}{\omega} = 1.$

The group delay $= -\dfrac{d\theta(\omega)}{d\omega} = \dfrac{-d}{d\omega}(-\omega) = 1.$