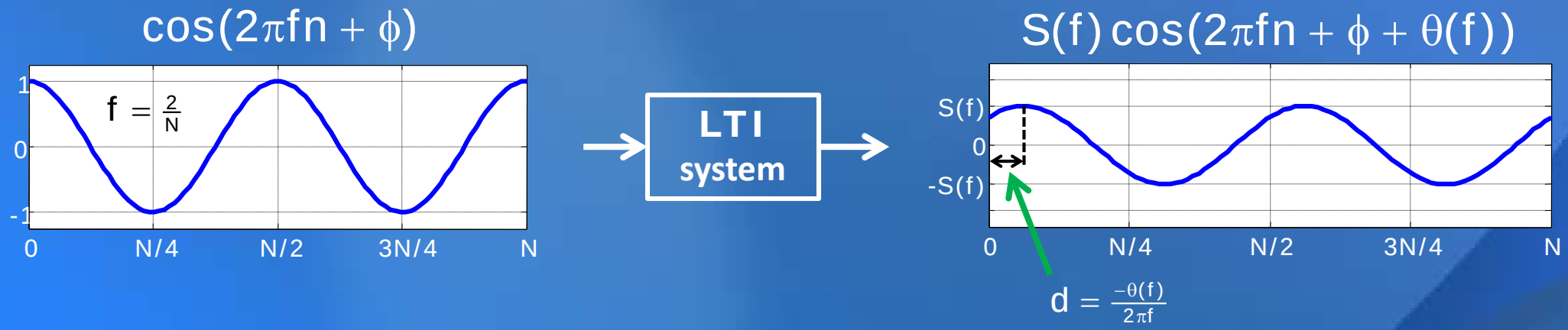
Frequency Response

Frequency Response

The response of any LTI system to an input cosine wave is a cosine wave with the same frequency f, but scaled in amplitude by S(f) and shifted in phase by θ(f).



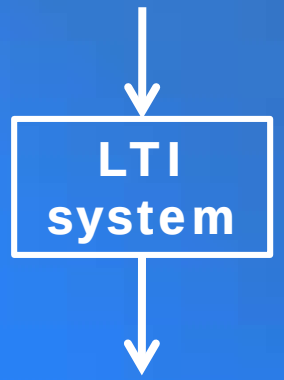
The scaling and shift are frequency dependent

- **S(f) is known as the amplitude response of the filter.**
- **θ(f) is known as the phase response.**
- **Together, they are referred to as the frequency response.**

Computing the Output

Step 1: Express the input as the sum of cosines

$$x(n) = A_1 \cos(2\pi f_1 n + \phi_1) + A_2 \cos(2\pi f_2 n + \phi_2) + \ldots$$



Step 2: Scale and shift each cosine

$$y(n) = S(f_1)A_1 \cos(2\pi f_1 n + \phi_1 + \theta(f_1)) + S(f_2)A_2 \cos(2\pi f_2 n + \phi_2 + \theta(f_2)) + \ldots$$

Step 3: By linearity, add the results together

Amplitude Responses