

### Problem 3.16

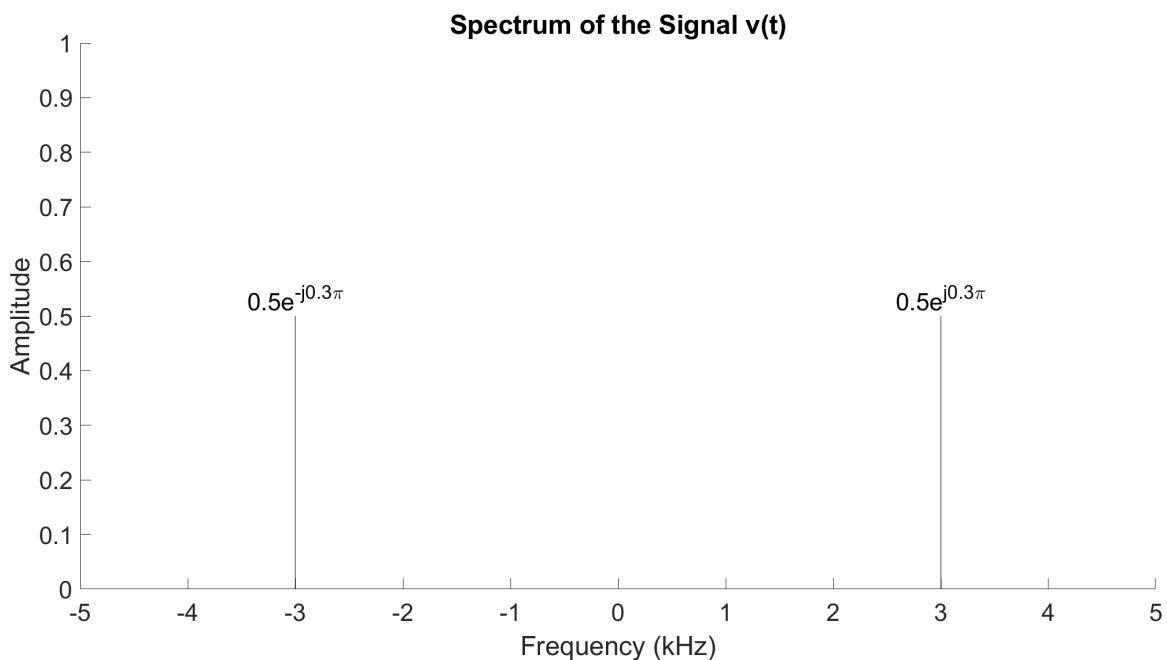
Given,  $x(t) = (v(t) + A)\cos(2\pi(680 \times 10^3)t)$  where  $A$  is a constant.  $x(t)$  is the transmitted signal.  $v(t)$  is voice signal given by  $v(t) = \cos(2\pi(3000)t + 0.3\pi)$ .

(a) Let  $f_v = 3000$  Hz

Then , using Inverse Euler formula  $v(t)$  can be expressed as

$$v(t) = 0.5e^{j(0.3\pi)}e^{j(2\pi f_v t)} + 0.5e^{-j(0.3\pi)}e^{-j(2\pi f_v t)}$$

Spectrum for  $v(t)$



(b) Let  $f_x = 680,000$  Hz

Then,  $x(t)$  can be represented as :

$$x(t) = v(t)\cos(2\pi(f_x)t) + A\cos(2\pi(f_x)t)$$

$$\implies x(t) = 0.5\cos(2\pi(f_x + f_v)t) + 0.3\pi) +$$

$$0.5\cos(2\pi(f_x - f_v)t + 0.3\pi) + 1.5\cos(2\pi f_x t)$$

Using Inverse Euler formula we have,

$$x(t) = 0.25e^{j(0.3\pi)}e^{j(2\pi(f_x+f_v)t)} + 0.25^{-j(0.3\pi)}e^{-j(2\pi(f_x-f_v)t)}$$

$$+ 0.25^{j(0.3\pi)}e^{j(2\pi(f_v-f_x)t)} + 0.25^{-j(0.3\pi)}e^{-j(2\pi(-f_v-f_x)t)} + 0.75e^{j(2\pi f_x t)} +$$

$$0.75e^{-j(2\pi f_x t)}$$

### Spectrum for $x(t)$

Note:  $f_x = 680,000$  Hz and  $f_v = 3000$  Hz

