Principles of Communications

ECS 332

Asst. Prof. Dr. Prapun Suksompong

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4. Amplitude Modulation

Office Hours:

BKD, 6th floor of Sirindhralai building

Tuesday	**9:00-10:00**
Wednesday	**14:20-15:20**
Thursday	**9:00-10:00**

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4.1 DSB-SC

Office Hours:

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Tuesday	**9:00-10:00**
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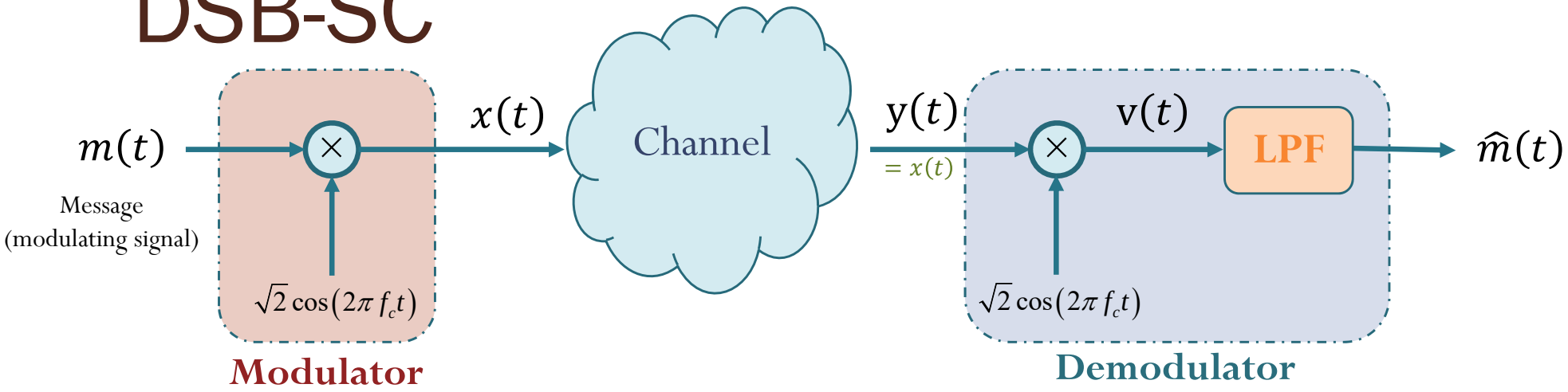
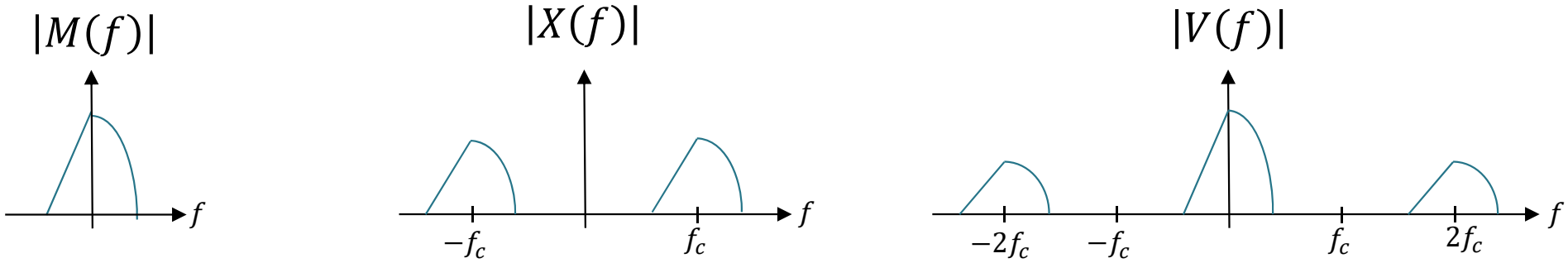
Thursday	**9:00-10:00**

DSB-SC





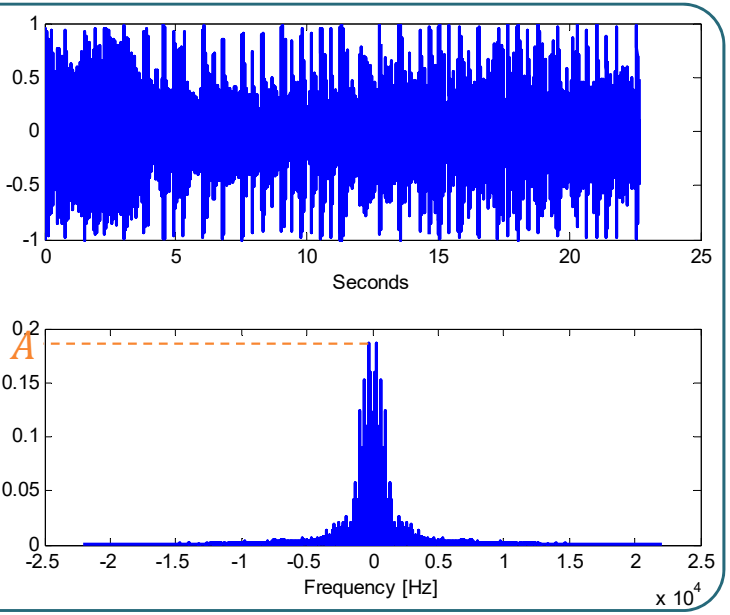
Key equation:

$$\text{LPF}\left\{\underbrace{\left(m(t)\times\sqrt{2}\cos(2\pi f_c t)\right)}_{x(t)}\times\left(\sqrt{2}\cos(2\pi f_c t)\right)\right\}_{v(t)} = m(t)$$

[Demo_DSBSC_Sound_ReadWAV.m]

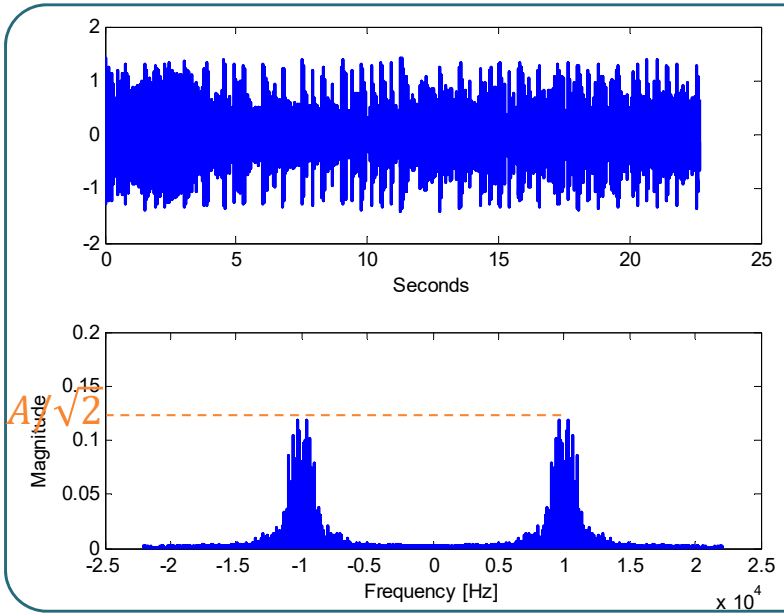
DSB-SC

$m(t)$



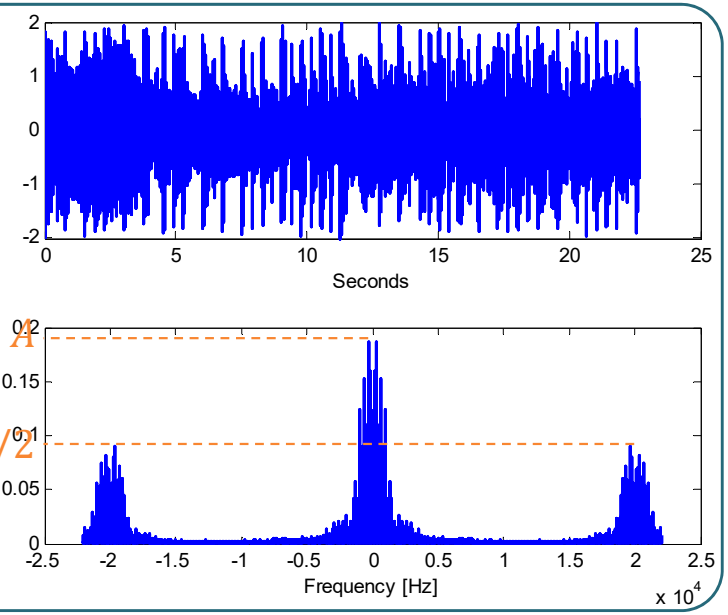
$|M(f)|$

$x(t)$



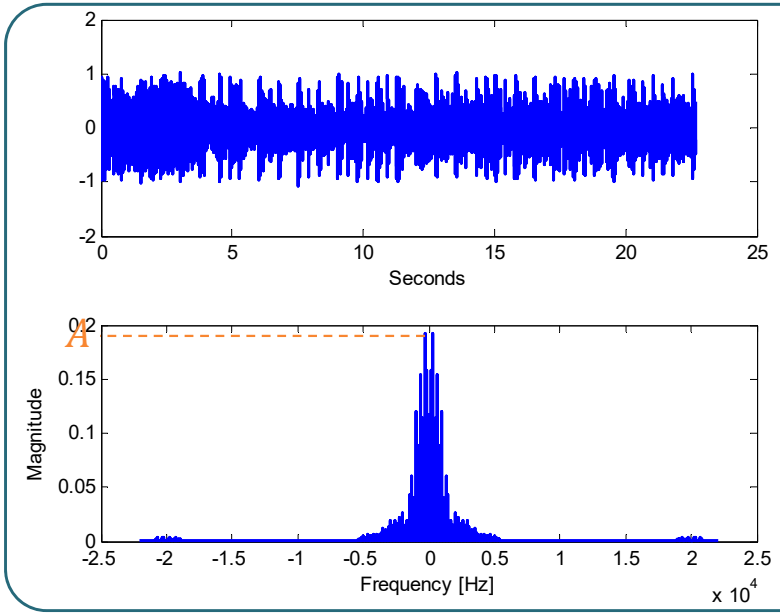
$|X(f)|$

$v(t)$



$|V(f)|$

$\hat{m}(t)$



$|\hat{M}(f)|$

In the time domain…

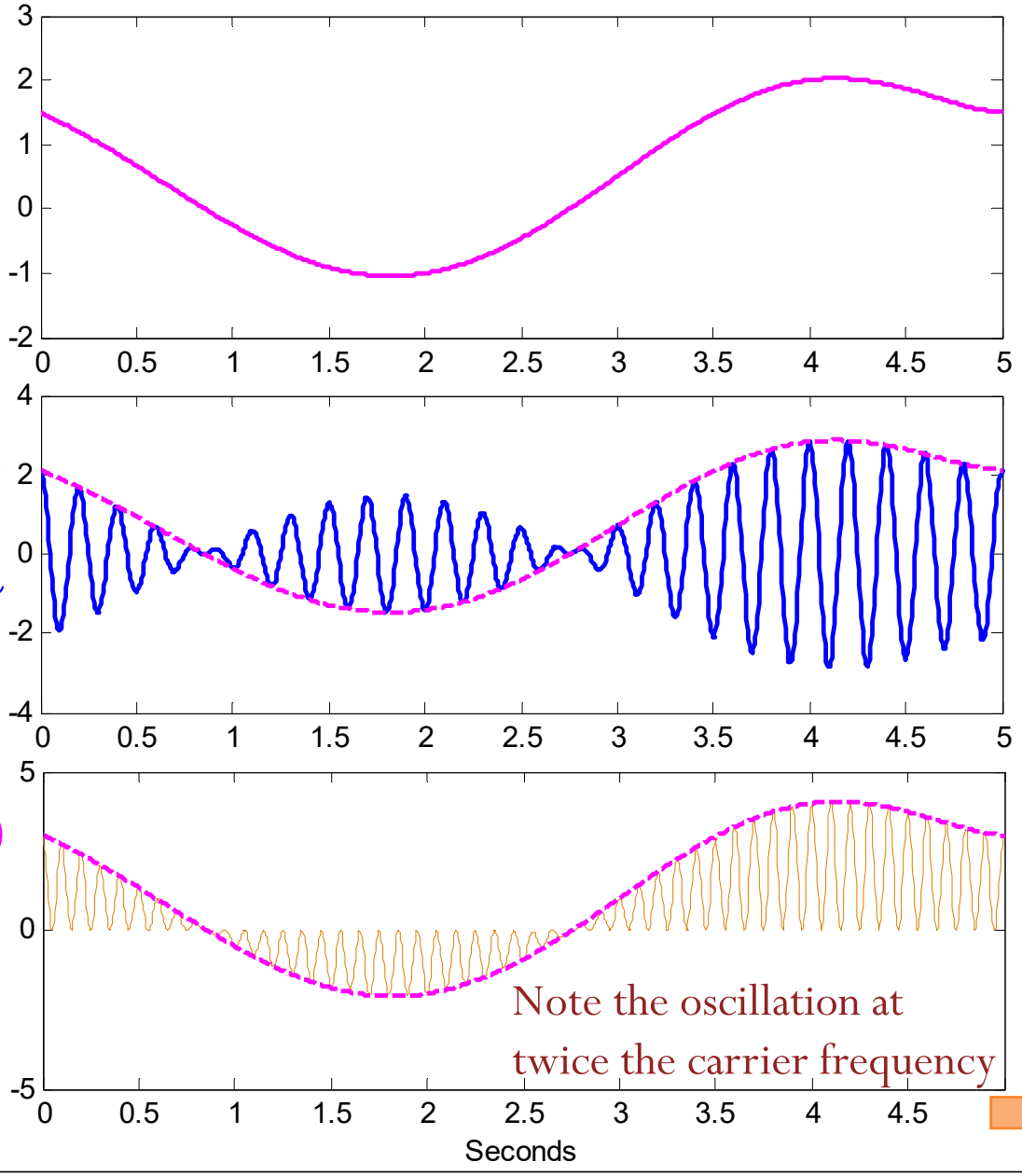
$m(t)$

$\sqrt{2}m(t)$

$\overbrace{m(t)} \times \sqrt{2}\cos(2\pi f_c t) = \underbrace{x(t)}$

$2m(t)$

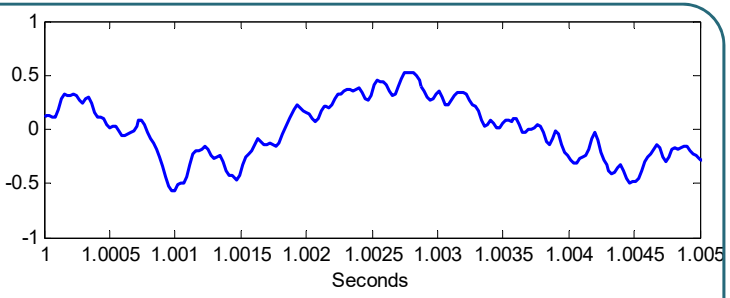
$\overbrace{x(t)} \times \sqrt{2}\cos(2\pi f_c t) = v(t)$



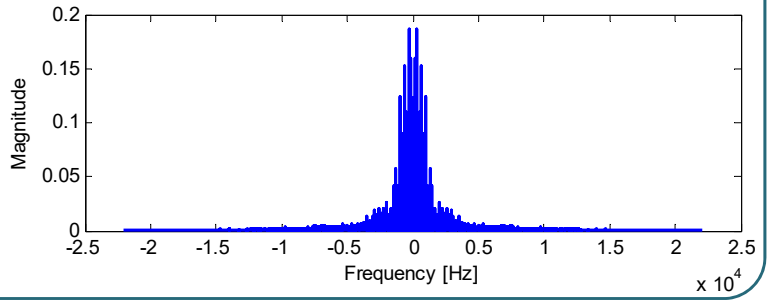
DSB-SC (Zoomed in time)

Note how the baseband signal $m(t)$ becomes the envelope of the modulated signal $x(t)$.

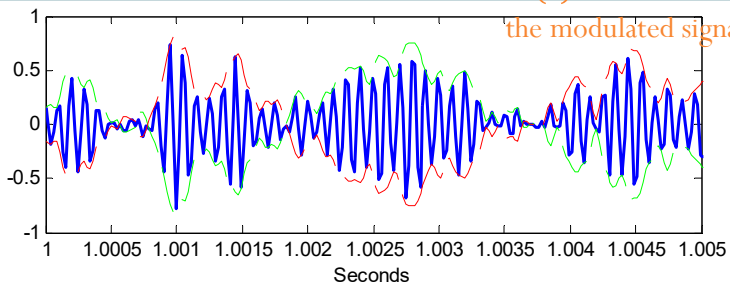
$m(t)$



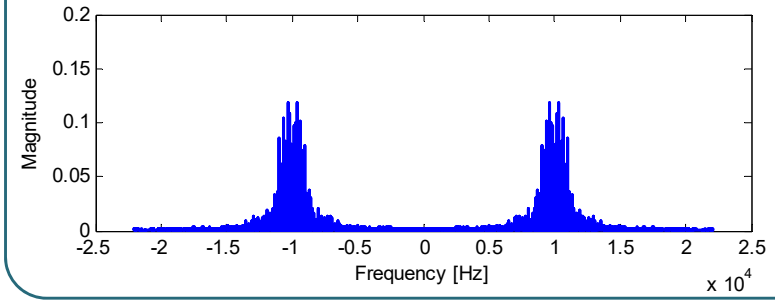
$|M(f)|$



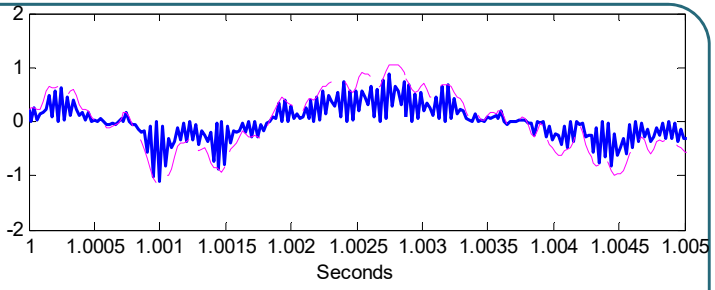
$x(t)$



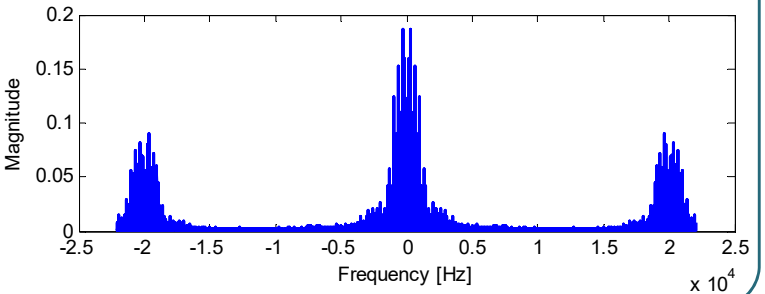
$|X(f)|$



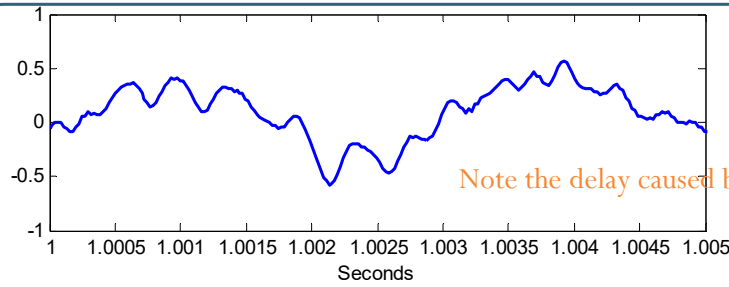
$v(t)$



$|V(f)|$

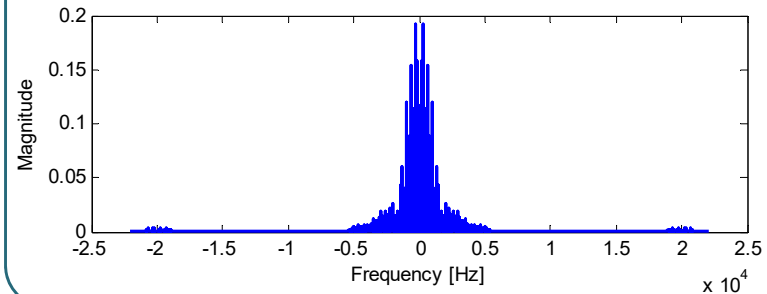


$\widehat{m}(t)$

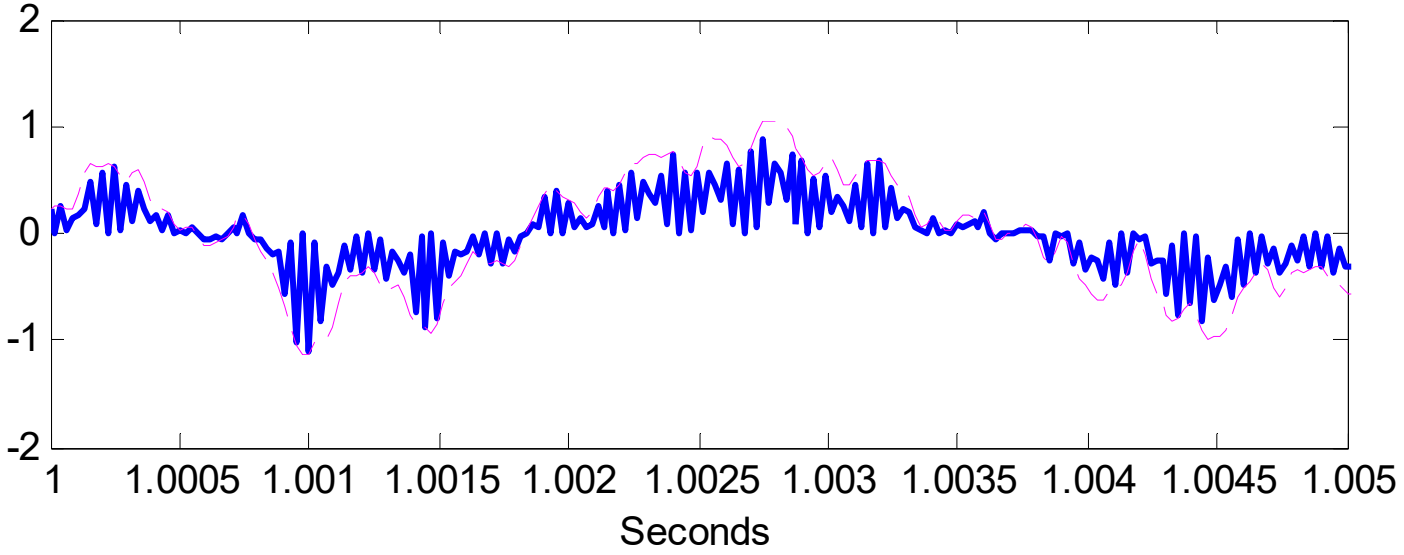


Note the delay caused by the LPF.

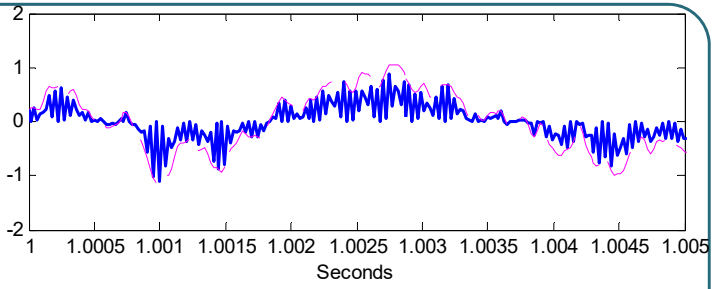
$|\widehat{M}(f)|$



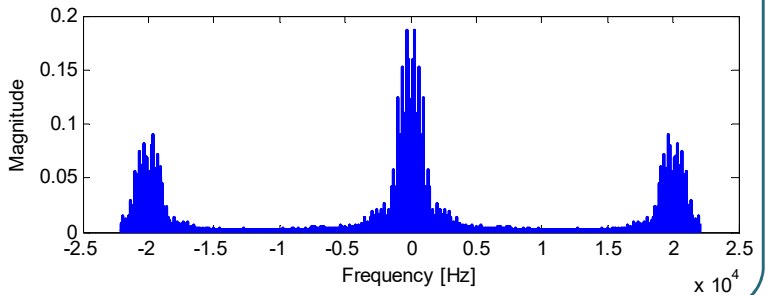
$v(t)$ (Zoomed in time)



$v(t)$



$|V(f)|$



In the time domain… we expect

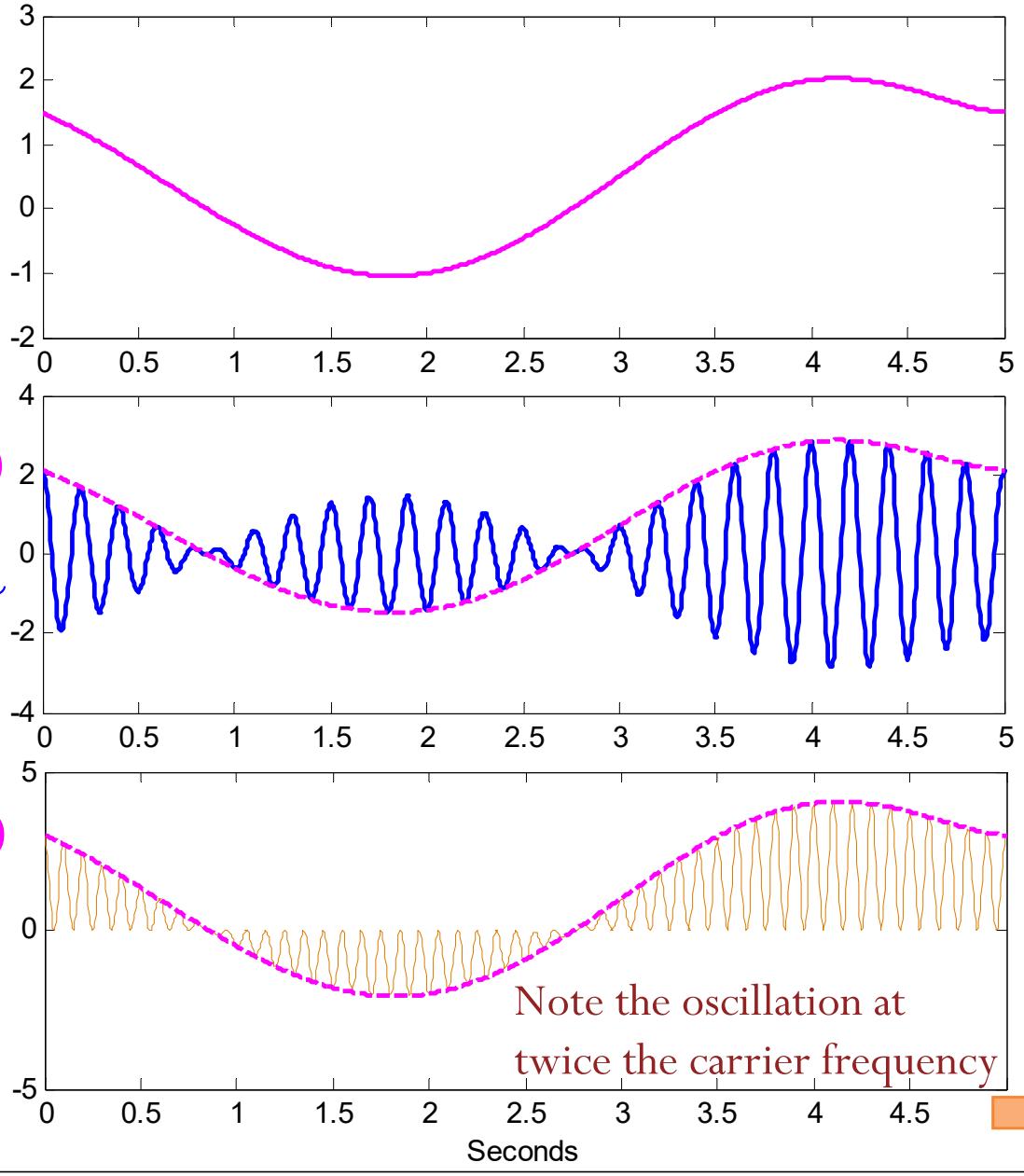
$m(t)$

$\sqrt{2}m(t)$

$\overbrace{m(t)} \times \sqrt{2}\cos(2\pi f_c t) = \underbrace{x(t)}$

$2m(t)$

$\overbrace{x(t)} \times \sqrt{2}\cos(2\pi f_c t) = v(t)$



In the time domain…

When the sampling rate is not fast enough,…

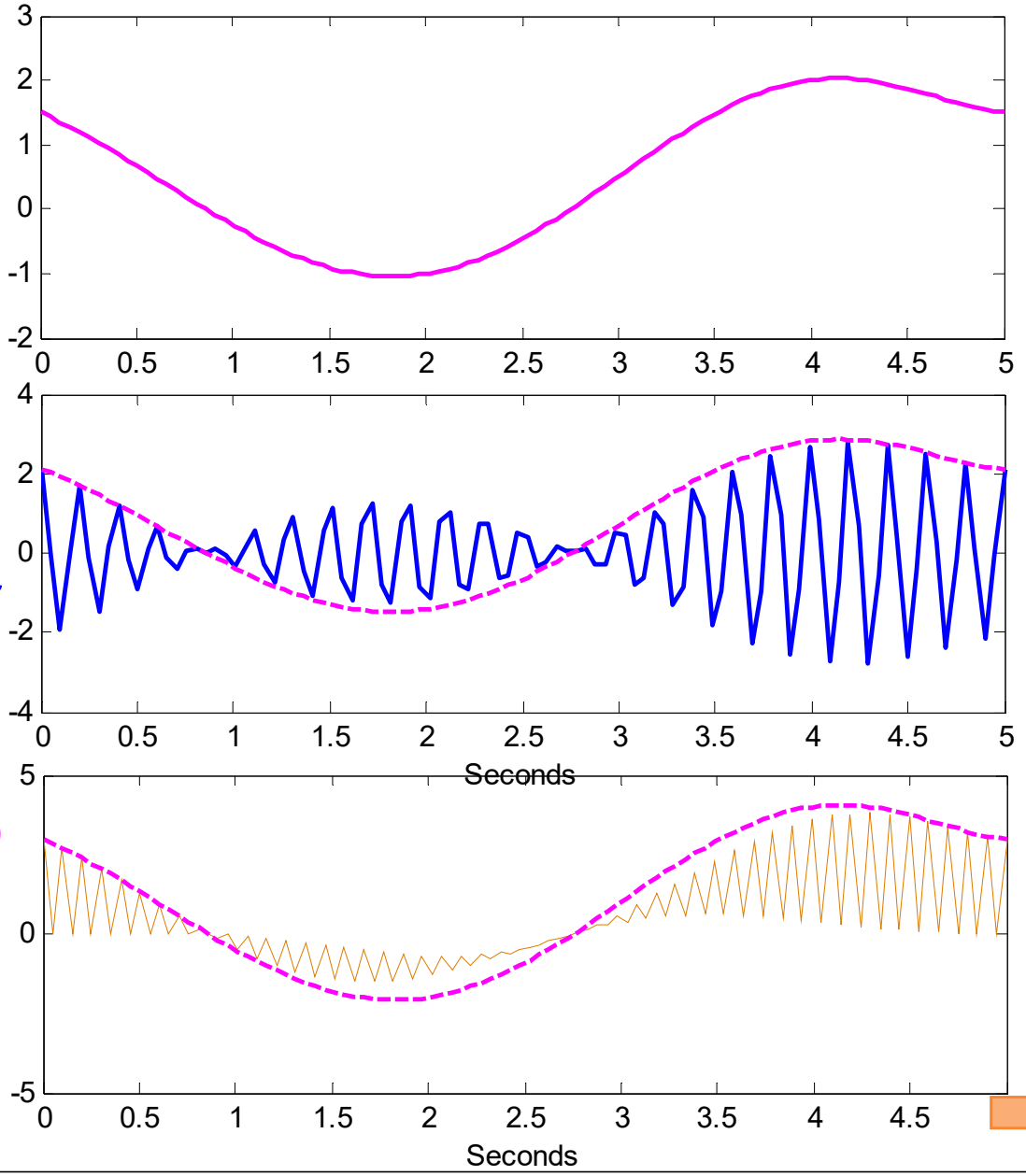
$m(t)$

$\sqrt{2}m(t)$

$$\underbrace{m(t)}_{} \times \sqrt{2}\cos(2\pi f_c t) = \underbrace{x(t)}_{}$$

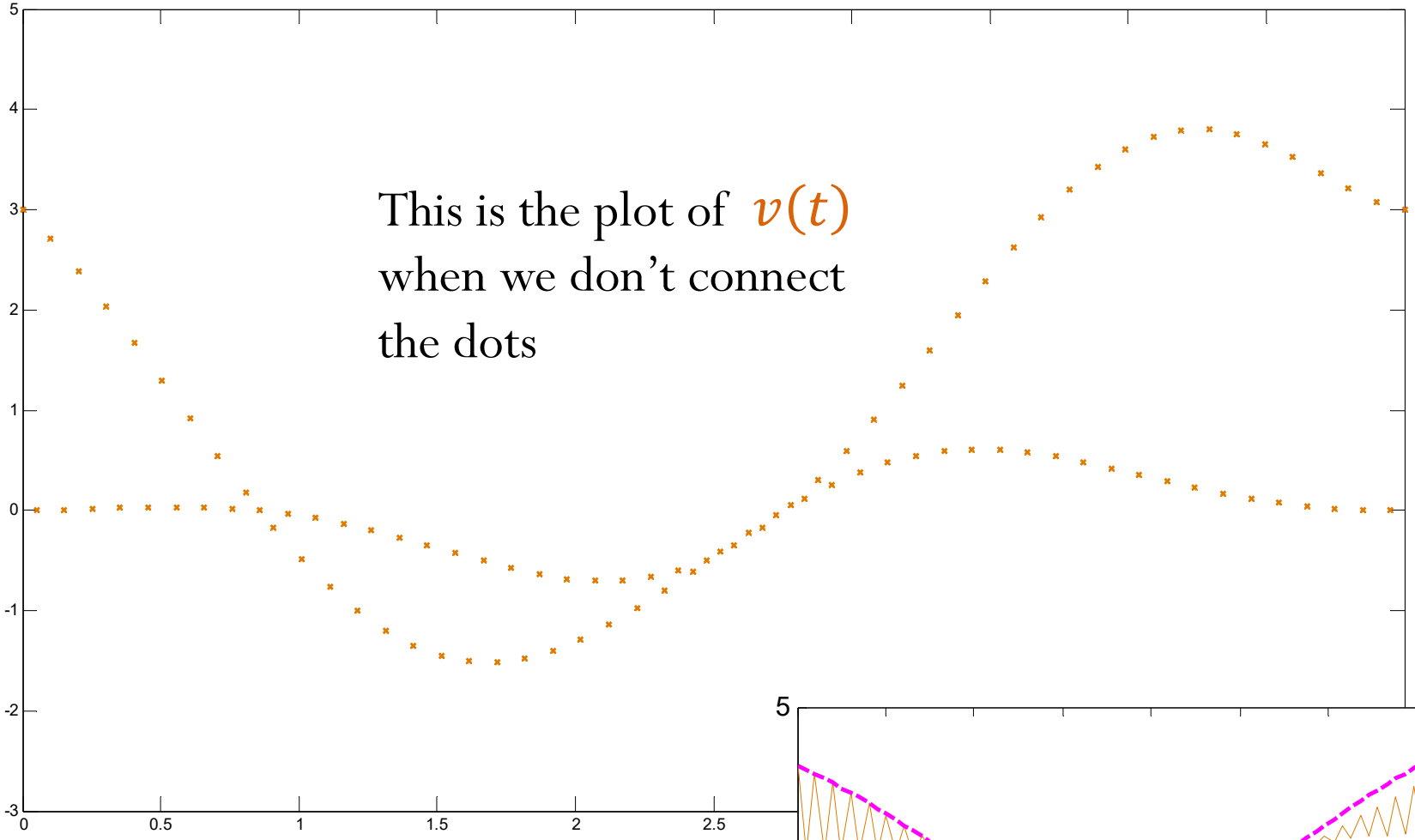
$2m(t)$

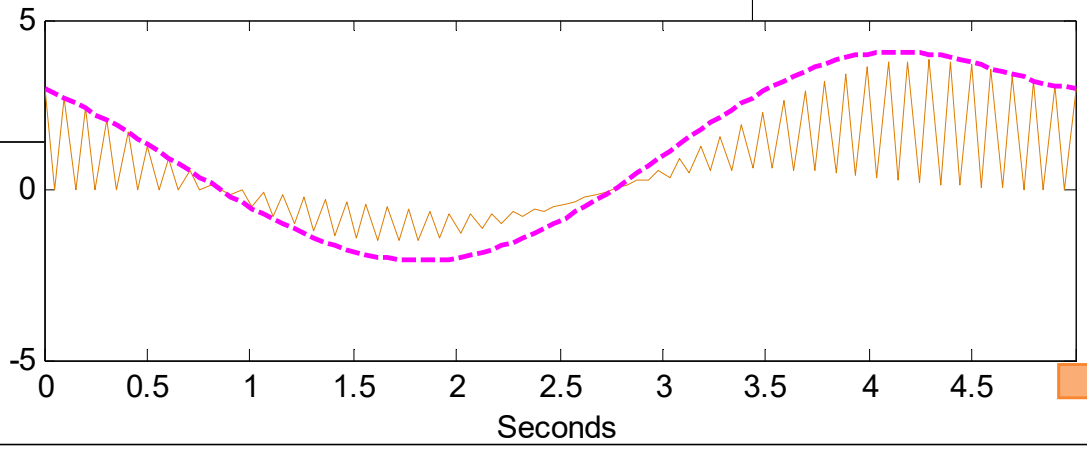
$$\underbrace{x(t)}_{} \times \sqrt{2}\cos(2\pi f_c t) = v(t)$$



The problem with sampling rate

This is the plot of $v(t)$ when we don't connect the dots





The problem with sampling rate