PROB: Using the Rosetta Stone method and the blank diagrams below, show the time-domain waveforms and spectra for AM modulation/demodulation on the axes below. That is, plot the following time-domain signals on the left side and their corresponding spectrums on the right side:

Line 1) $v_{AM}(t) = e^{-\pi t^2}$ (original signal)

2) $\cdot \cos(2\pi \cdot 2t)$ (AM modulation, means multiply by carrier signal)

3) $= v_{AM}(t) = e^{-\pi t^2} \cos(2\pi \cdot 2t)$ (AM sig modulated at frequency 2)

2nd diagram

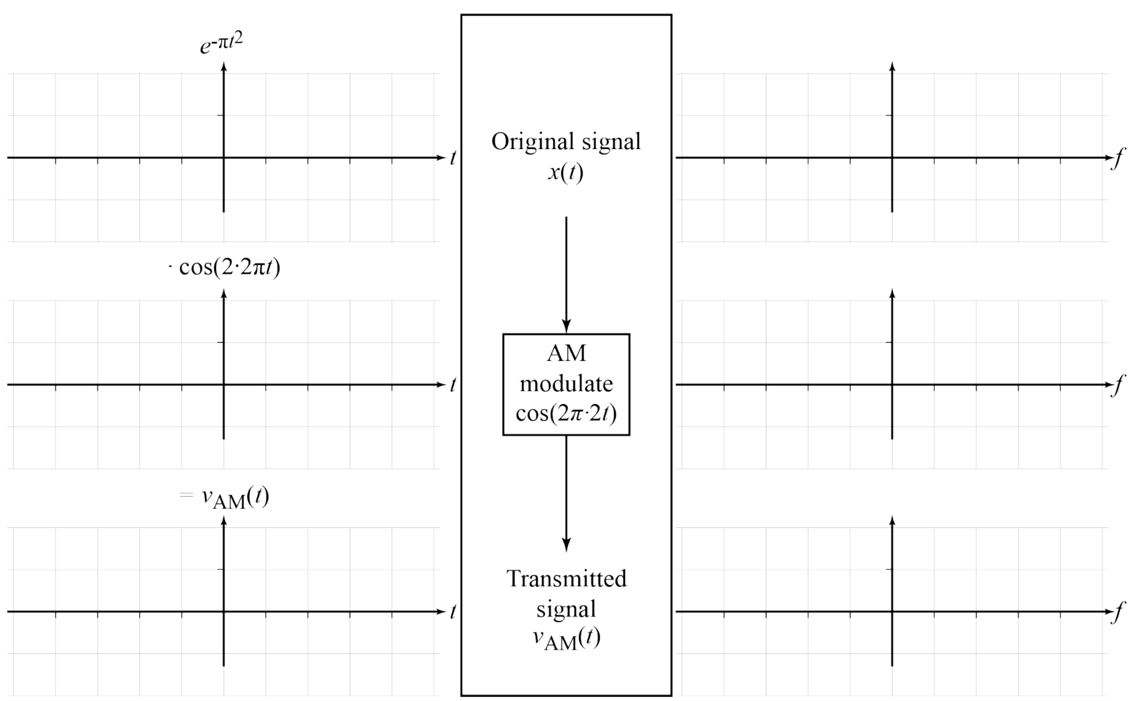
1) $= v_{AM}(t) = e^{-\pi t^2} \cos(2\pi \cdot 2t)$ (copy of last line of 1st diagram)

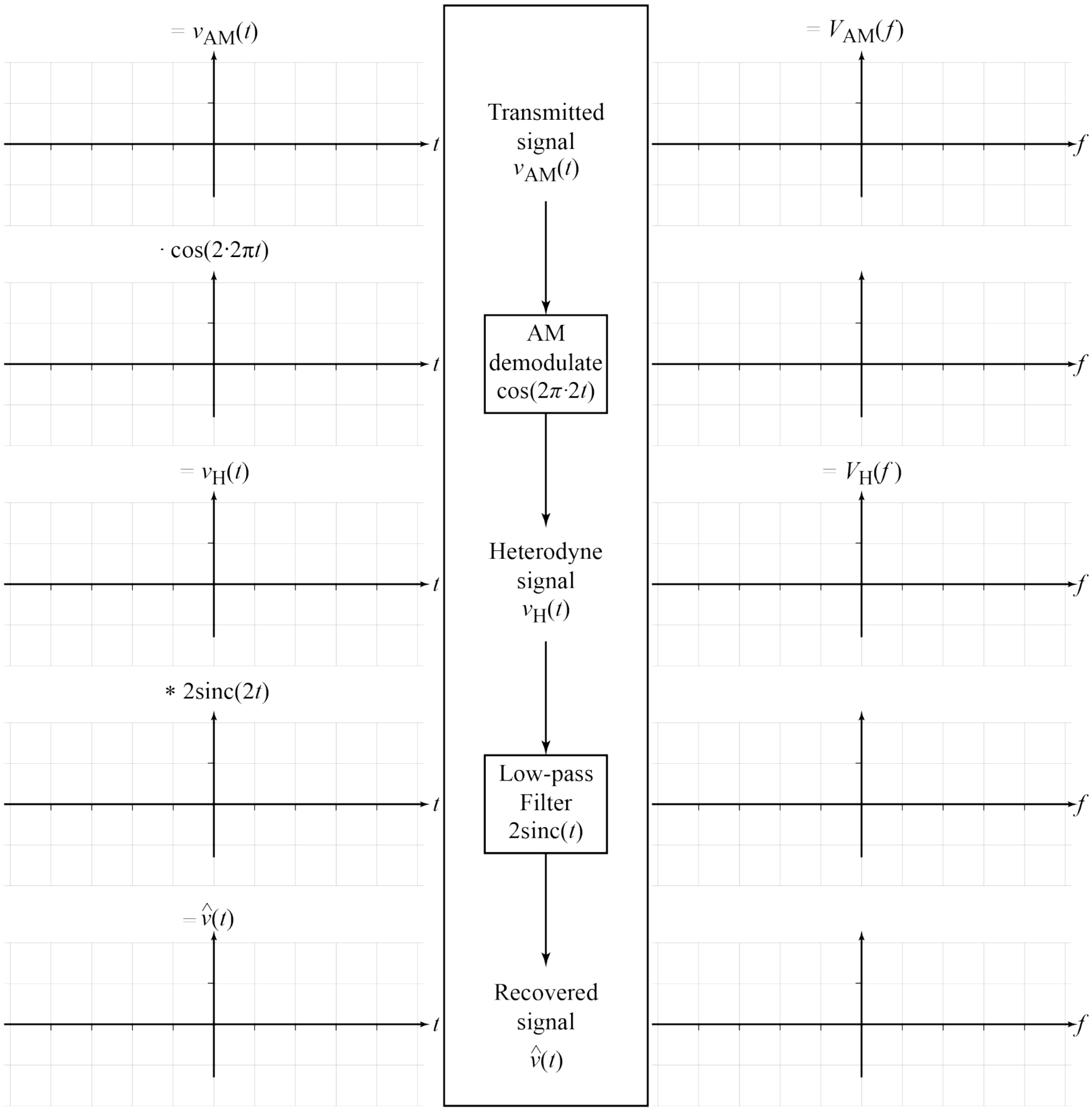
2) $\cdot \cos(2\pi \cdot 2t)$ (AM demodulation, multiply by carrier signal again)

3) $= v_H(t) = e^{-\pi t^2} \cos^2(2\pi \cdot 2t) = e^{-\pi t^2} \left[\frac{1}{2} + \frac{1}{2} \cos(2\pi \cdot 4t) \right]$

4) $* \, 2\text{sinc}(2t)$ (ideal low-pass filter, rect func in f with bandwidth 2)

5) $= \hat{v}(t) \approx v(t) = e^{-\pi t^2}$





Solution below.

SOLN: Diagram for modulation:

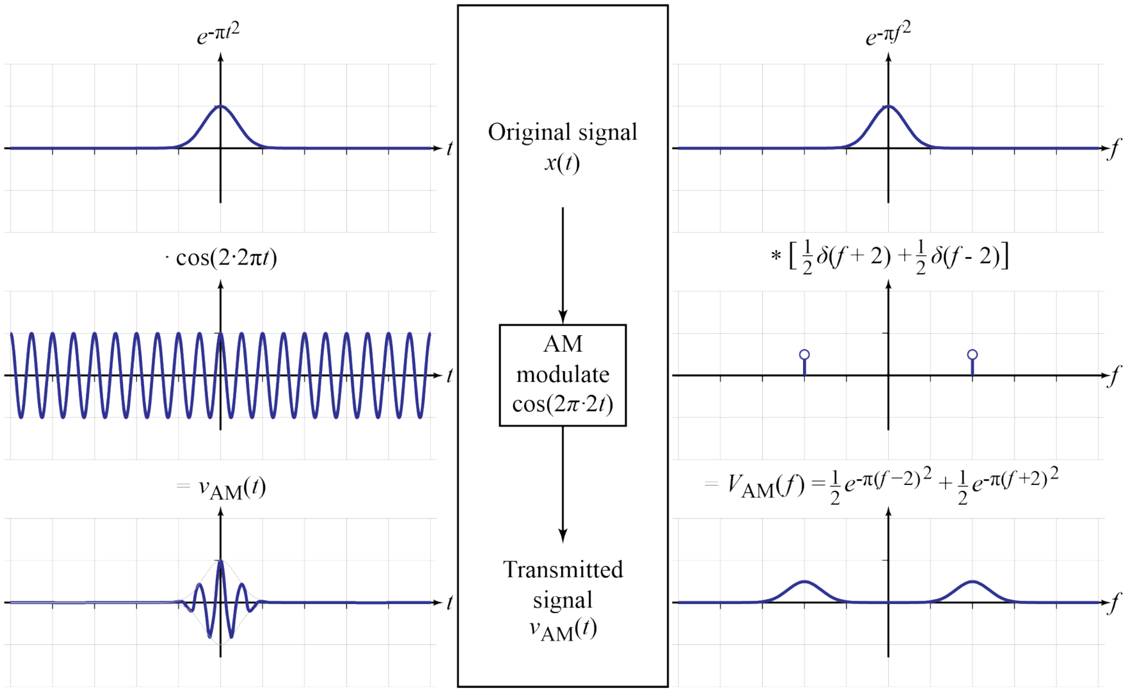
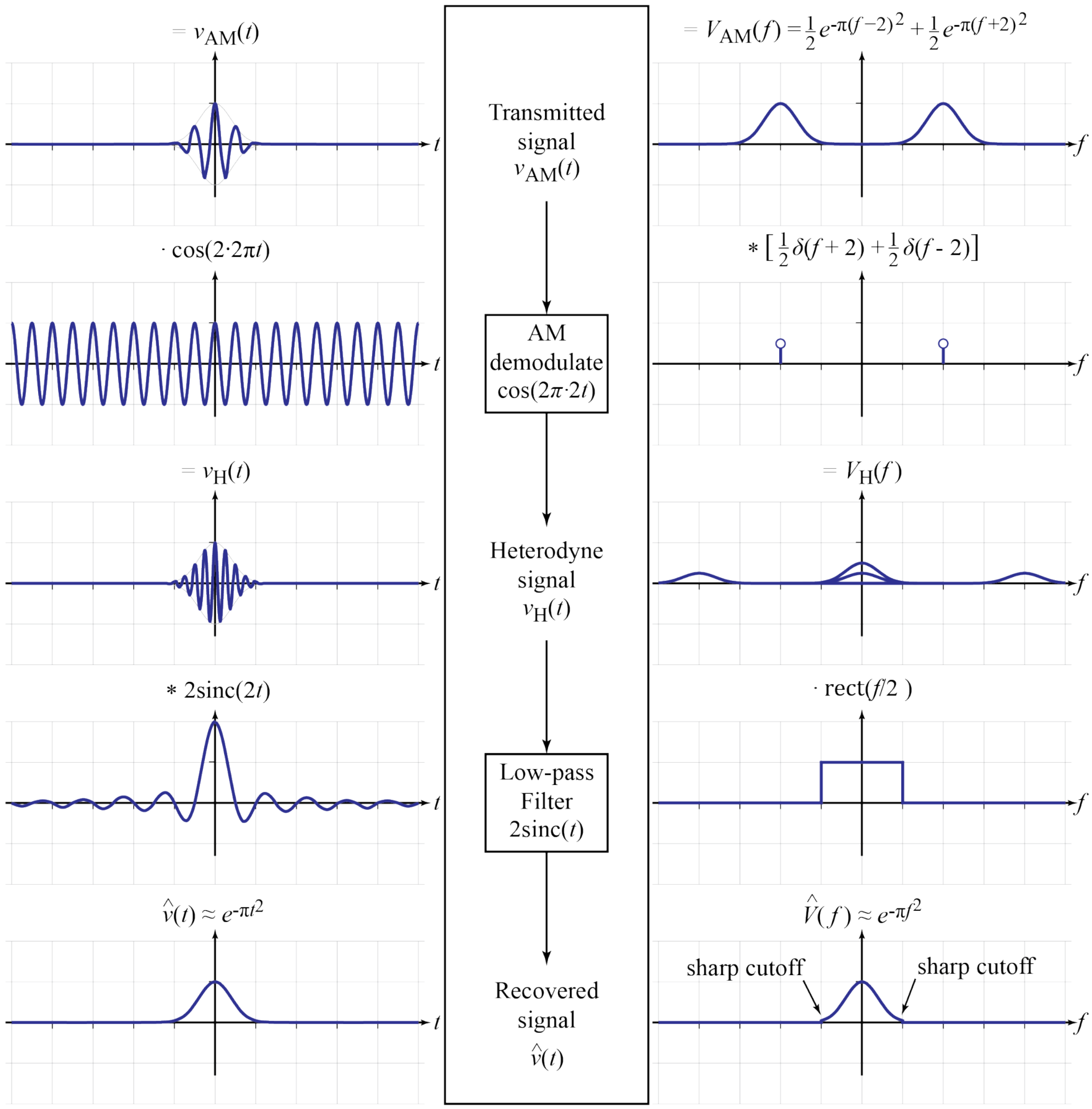


Diagram for demodulation (continuing from modulation diagram):



NOTE: The spectrum of the final signal, $\hat{V}(f)$, drops sharply to zero at f = 1, causing some of the high-frequency tails to be lost. We would recover more of the original signal if we used a wider low-pass filter. However, we would have more aliasing. Also, although the spectral tails are small in amplitude for $|f| > \pm 2\,\text{Hz}$, there is some aliasing in the modulated signals.