Problem 3.18

(a) We are given

$c(t) = 50\cos(100\pi t)\text{volts}, \qquad f_c = 50\text{Hz}$

and

$m(t) = 20\cos(2\pi t)\text{volts}, \qquad f_m = 1\text{Hz}$

The resulting AM wave is

$$s(t) = [1 + k_a m(t)]c(t)$$
$$= 50[1 + 20k\cos(2\pi t)]\cos(100\pi t) \qquad (1)$$

A percentage modulation of 75% corresponds

$20k = 0.75$

or

$k = 0.0375$

Accordingly, we may rewrite Eq. (1) as

$$s(t) = 50[1 + 0.75\cos(2\pi t)]\cos(100\pi t) \qquad (2)$$

Equation (2) is plotted in Fig. 1.

(b) Expanding the AM wave s(t) of Eq. (2) into its spectral components, we write

$$s(t) = 50\cos(100\pi t) + 37.5\cos(2\pi t)\cos(100\pi t)$$
$$= 50\cos(100\pi t) + 18.75[\cos(102\pi t) + \cos(98\pi t)]\text{volts}$$

The power developed across a 100-ohm load by this AM wave is therefore

$$P = \frac{1}{2}\ \frac{(50)^2}{100} + \frac{1}{2}\ \frac{(18.75)^2}{100} + \frac{1}{2}\ \frac{(18.75)^2}{100}$$
$$= 12.5 + 3.426$$
$$= 15.926 \text{ watts}$$

This result shows that the carrier contributes about 80% of the power delivered to the load.

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Problem 3.18 continued

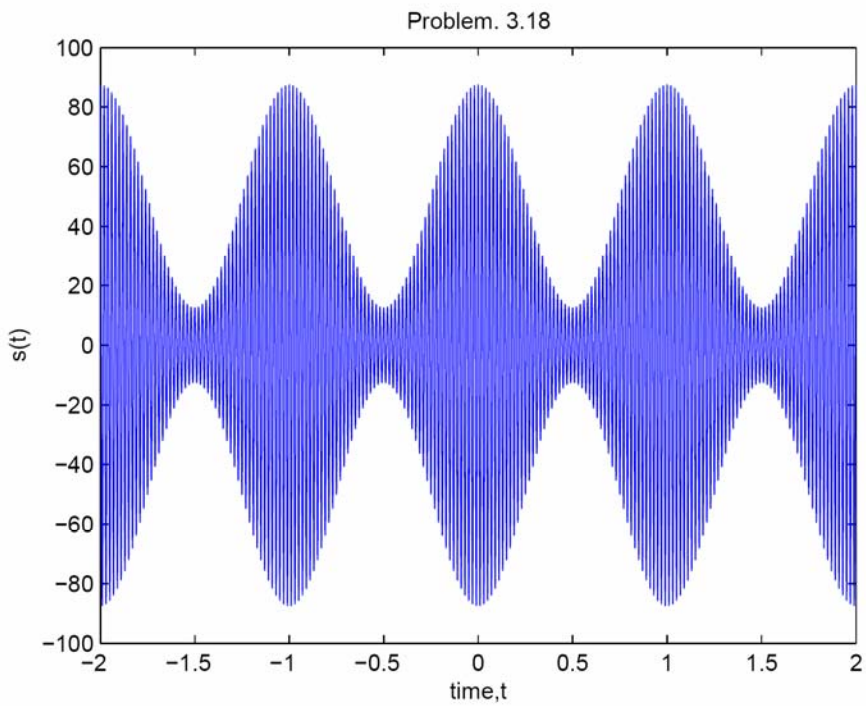

Figure 1: Problem 3.18