Problem 3.21

We are given

$m(t) = A_c \cos(2\pi f_m t)$

and

$c(t) = A_c \cos(2\pi f_c t + \phi)$

The AM wave is therefore

$$\begin{aligned} s(t) &= [1 + k_a m(t)]c(t) \\ &= A_c[1 + k_a A_m \cos(2\pi f_m t)]\cos(2\pi f_c t + \phi) \\ &= A_c[1 + \mu \cos(2\pi f_m t)]\cos(2\pi f_c t + \phi) \end{aligned} \qquad (1)$$

The focus in this problem is to see how varying the phase ϕ affects the waveform of the AM signal $s(t)$. We may thus set the following parameters:

$\mu = k_a A_m = 0.5$

$A_c = 1$ volt

$f_m = 1\text{Hz}$

and

$f_c = 5\text{Hz}$

Then, Eq. (1) assumes the form

$$s(t) = [1 + 0.5\cos(2\pi t)]\cos(10\pi t + \phi) \qquad (2)$$

Equation (2) is plotted in Fig. 1 for the prescribed values $\phi = 0^o, 45^o, 90^o$, and 135^o. Examining these four waveforms, we may make the following observation:

- Insofar as the envelope of the AM wave is concerned, varying the carrier phase ϕ has no effect whatsoever on the waveform of the envelope, which is intuitively satisfying.
- The only visible effect of varying the carrier phase ϕ is a shift in the uniformly spaced zero-crossings of the AM wave.

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Problem 3-21 continued

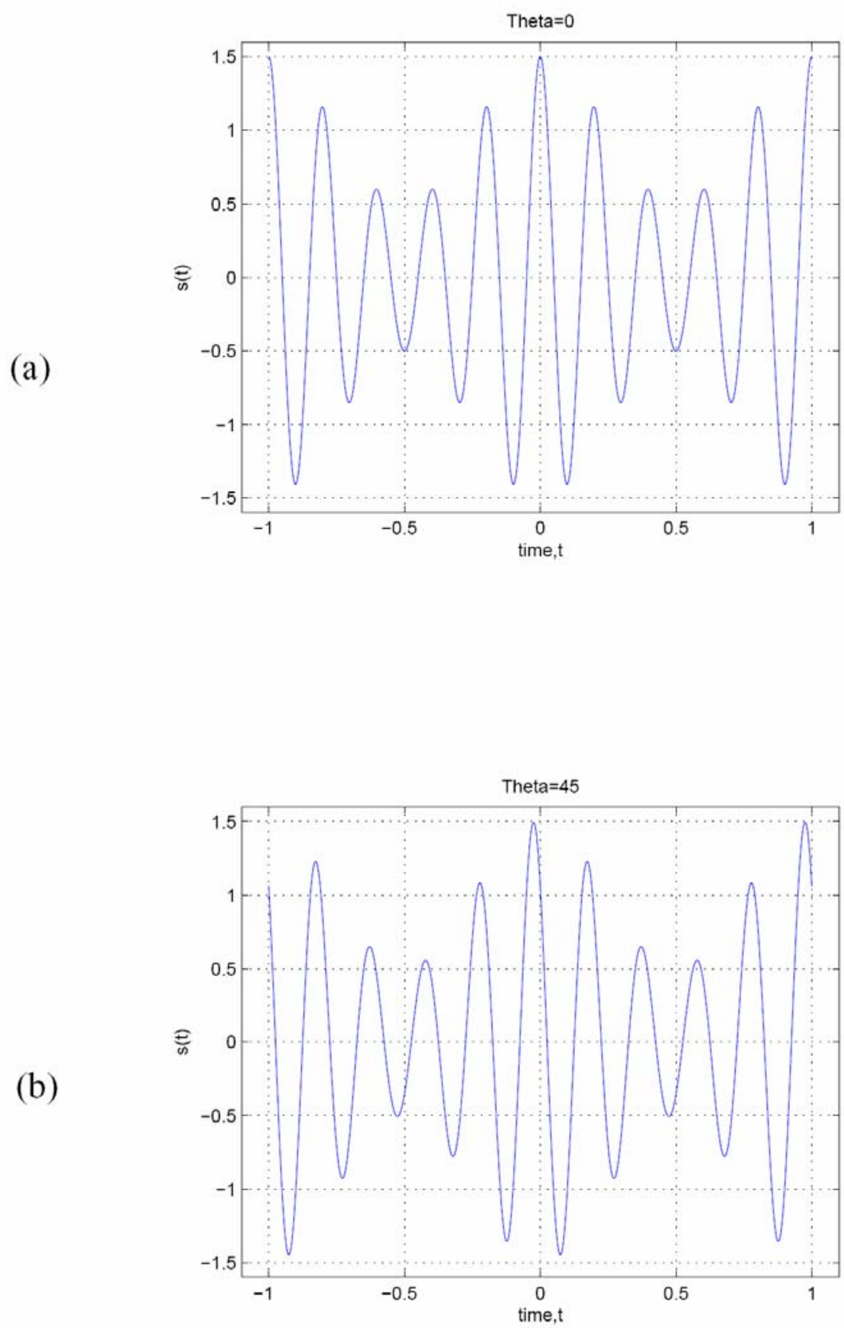

Figure 1: Problem 3.21

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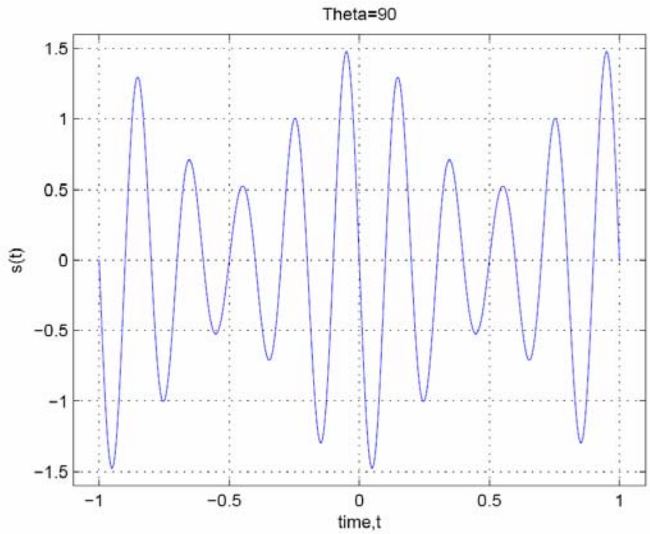
Problem 3-21 continued

(c)



(d)

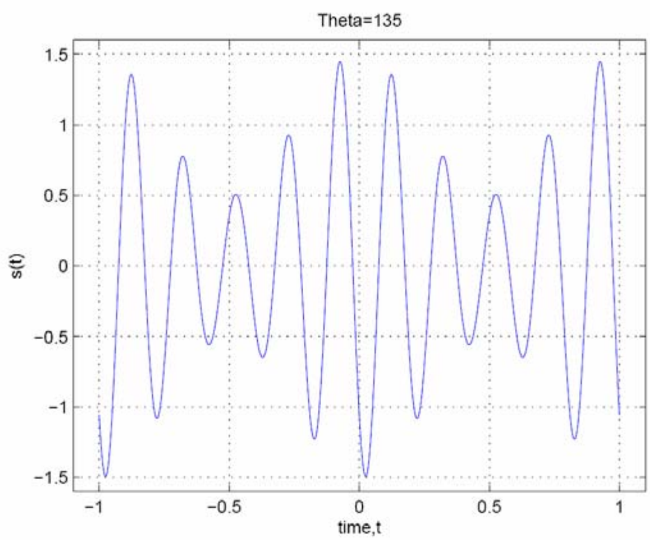


Figure 1 (continued): Problem 3.21