We now expand the last term of (6) by means of the identity

$$\sin A \sin B = \tfrac{1}{2}[\cos(A - B) - \cos(A + B)]$$

to obtain

$$mE_0(\sin \omega_a t \sin \omega_c t) = \tfrac{1}{2}\, mE_0[\cos(\omega_c t - \omega_a t) - \cos(\omega_a t + \omega_c t)] \quad (7)$$

By substituting (7) into (6), we obtain

$$e = E_0 \sin \omega_c t + \frac{mE_0}{2} \cos(\omega_c t - \omega_a t) - \frac{mE_0}{2} \cos(\omega_a t + \omega_c t) \quad (8)$$

Equation (8) shows that the modulated carrier is made up of three sinusoidal waves, each at a different frequency. The first of these, represented by the term $E_0 \sin \omega_c t$, is at the carrier frequency and of the same amplitude as the unmodulated carrier. That is, the carrier frequency component of modulated wave remains unchanged when modulation is applied.

The last two terms in (8) represent the sidebands resulting from sinusoidal modulation. Both are of the same amplitude ($mE_0/2$, peak value). One of the sidebands is below the carrier frequency by the amount of the audio frequency (that is, radian frequency $= \omega_c t - \omega_a t$), and the other is above the carrier by the audio frequency. In other words it's the sidebands that contain the audio information.

LESSON 5146-2

TRIGONOMETRIC EQUATIONS AND IDENTITIES

EXAMINATION

Mail in this and all examinations promptly, as they are completed. Then start on the next lesson.

1. $\sin^4 x + \cos^4 x =$ ________
   (1) $-2\sin^2 x \cos^2 x$
   (2) $1 + 2\sin^2 x - 2\sin^4 x$
   (3) $1 + 3\sin^3 x - 2\sin^2 x$
   (4) $1 - 2\sin^2 x + 2\sin^4 x$
   (5) 0