Example: Consider a composite signal defined by

$$s(t) = 1 - \sin 4t \;[4\cos 2t - 2\sin(-4t)]$$

Using trigonometric identities, decompose the composite signal, $s(t)$, into a linear combination of simple sine functions, i.e., $\sum_{i=1}^{n} A_i \sin(2\pi f_i t + \theta_i)$.

Solution:

$$\begin{aligned} s(t) &= 1 - \sin 4t \;[4\cos 2t - 2\sin(-4t)] \\ &= 1 - 4\sin 4t\cos 2t + 2\sin 4t\sin(-4t) \end{aligned}$$

Use trig identity: $\sin a\cos b = \frac{1}{2}[\sin(a+b) + \sin(a-b)]$

$$= 1 - (4)\left(\frac{1}{2}\right)[\sin(4t+2t) + \sin(4t-2t)] + 2\sin 4t\sin(-4t)$$

$$= 1 - 2\sin 6t - 2\sin 2t + 2\sin 4t\sin(-4t)$$

Use trig identity: $\sin(-a) = -\sin a$

$$= 1 - 2\sin 6t - 2\sin 2t - 2\sin 4t\sin 4t$$

$$= 1 - 2\sin^2 4t - 2\sin 6t - 2\sin 2t$$

Use trig identity: $1 - 2\sin^2 a = \cos 2a$

$$= \cos 8t - 2\sin 6t - 2\sin 2t$$

Use trig identity: $\cos a = \sin(\frac{\pi}{2} - a)$

$$= \sin\left(\frac{\pi}{2} - 8t\right) - 2\sin 6t - 2\sin 2t$$

Use trig identity: $\sin(-a) = -\sin a$

$$= -\sin(8t - \frac{\pi}{2}) - 2\sin 6t - 2\sin 2t$$