

## Harmonic Addition Theorem

Let  $f(\theta) = a \cos(\theta) + b \sin(\theta)$ . It can be expressed as  $f(\theta) = g \cos(\theta + h)$ . Here's how:

Step 1 - Use Trig. Addition Formula

$$\therefore f(\theta) = g [\cos(\theta)\cos(h) - \sin(\theta)\sin(h)]$$

Step 2 - Note Original Equation

$$\therefore a = \underset{\substack{\downarrow \\ E_1}}{g \cos(h)} \quad \text{and} \quad b = \underset{\substack{\downarrow \\ E_2}}{g \sin(h)}$$

Step 3 - Solve for  $g$

$$\therefore (E_1)^2 + (E_2)^2 \rightarrow a^2 + b^2 = g^2 \rightarrow g = \pm \sqrt{a^2 + b^2}$$

Step 4 - Solve for  $h$

$$\therefore \frac{E_2}{E_1} \rightarrow \frac{b}{a} = \tan(h)$$

Step 5 - Conditions

If  $h$  is in QI or QIV use the positive  $g$  value. Use the other value if not in those quadrants.

References

<http://mathworld.wolfram.com/HarmonicAdditionTheorem.html>