

## 2-2 Vraagstelling:

2-2 A particle is simultaneously subjected to three simple harmonic motions, all of the same frequency and in the  $x$  direction. If the amplitudes are 0.25, 0.20, and 0.15 mm, respectively, and the phase difference between the first and second is  $45^\circ$ , and between the second and third is  $30^\circ$ , find the amplitude of the resultant displacement and its phase relative to the first (0.25-mm amplitude) component.

### Oplossing:

$$x_1 = 0.25 \cos \omega t$$

$$x_2 = 0.20 \cos \left( \omega t + \frac{\pi}{4} \right)$$

$$x_3 = 0.15 \cos \left( \omega t + \frac{\pi}{4} + \frac{\pi}{6} \right)$$

Bepaal eerst  $x_1 + x_2$  en tel daarna bij dit resultaat  $x_3$  op.

$$\text{PS: } A \cos \alpha + B \cos \beta = (A + B) \cos \left( \frac{\alpha + \beta}{2} \right) \cos \left( \frac{\alpha - \beta}{2} \right)$$

Bepaal eerst  $x_1 + x_2$ :

$$\begin{aligned} x_1 + x_2 &= (0.25 + 0.20) \cos \left( \frac{\omega t + \omega t + \frac{\pi}{4}}{2} \right) \cos \left( \frac{\omega t - \omega t - \frac{\pi}{4}}{2} \right) = 0.45 \cos \left( \omega t + \frac{\pi}{8} \right) \cos \left( -\frac{\pi}{8} \right) \\ &= 0.45 * \cos \left( \frac{\pi}{8} \right) \cos \left( \omega t + \frac{\pi}{8} \right) = A \cos \left( \omega t + \frac{\pi}{8} \right) \text{ met } A = 0.45 \cos \left( \frac{\pi}{8} \right) \end{aligned}$$

Bepaal nu  $x_1 + x_2 + x_3$

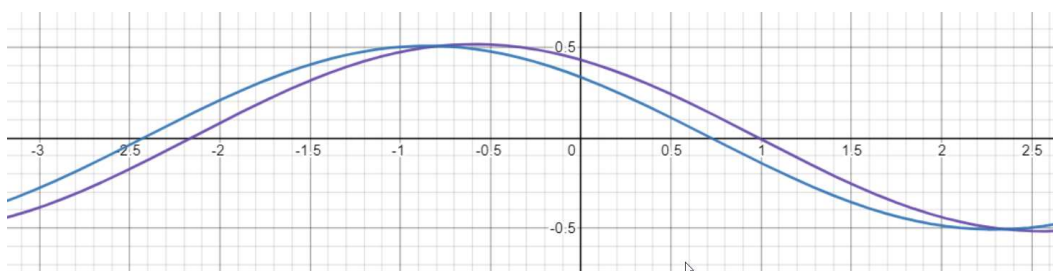
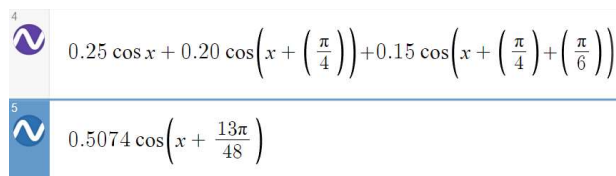
$$\begin{aligned} x_1 + x_2 + x_3 &= (A + 0.15) \cos \left( \frac{\omega t + \frac{\pi}{8} + \omega t + \frac{\pi}{4} + \frac{\pi}{6}}{2} \right) \cos \left( \frac{\omega t + \frac{\pi}{8} - \omega t - \frac{\pi}{4} - \frac{\pi}{6}}{2} \right) = \\ &= (A + 0.15) \cos \left( \frac{2\omega t + \frac{13\pi}{24}}{2} \right) \cos \left( \frac{-\frac{7\pi}{24}}{2} \right) = \\ &= (A + 0.15) \cos \left( \omega t + \frac{13\pi}{48} \right) \cos \left( \frac{-7\pi}{48} \right) = \\ &= \left( 0.45 * \cos \left( \frac{\pi}{8} \right) + 0.15 \right) \cos \left( \frac{7\pi}{48} \right) \cos \left( \omega t + \frac{13\pi}{48} \right) = 0.5074 \cos \left( \omega t + \frac{13\pi}{48} \right) \end{aligned}$$

$$\text{Antwoord: } x_1 + x_2 + x_3 = 0.5074 \cos \left( \omega t + \frac{13\pi}{48} \right)$$

### Controle dmv grafische plot

De paarse grafiek is de afzonderlijke som van  $x_1 + x_2 + x_3$

De zwarte grafiek is de weergave van  $0.5074 \cos \left( \omega t + \frac{13\pi}{48} \right)$



Ik verwacht dat de blauwe en de paarse grafiek over elkaar heen vallen, maar dat is NIET het geval. Waar zit de fout ?