

# 6.0 VEKSELSTRØM - GRUNNLEGGENDE BEGREPER

## 6.1 BEGREPER TIL SINUS-KURVE

### 6.1.1

$$U = \frac{U_m}{\sqrt{2}} = \frac{325,3\text{V}}{\sqrt{2}} = \underline{\underline{230\text{V}}}$$

### 6.1.2

$$I_m = I \cdot \sqrt{2} = 10\text{A} \cdot \sqrt{2} = \underline{\underline{14,1\text{A}}}$$

$$I_{\text{mid}} = \frac{2}{\pi} I_m = \frac{2}{\pi} \cdot 14,1\text{A} = \underline{\underline{9,0\text{A}}} \quad (\text{fra } 0 \text{ til } \pi)$$

### 6.1.3

$$U_{\text{mid}} = \frac{2}{\pi} \cdot U_m$$

$$U_m = \frac{U_{\text{mid}} \cdot \pi}{2} = \frac{200\text{V} \cdot \pi}{2} = \underline{\underline{314,2\text{V}}}$$

$$U = \frac{U_m}{\sqrt{2}} = \frac{314,2\text{V}}{\sqrt{2}} = \underline{\underline{222,2\text{V}}}$$

### 6.1.4

a)  $U_m = U \cdot \sqrt{2} = 440\text{V} \cdot \sqrt{2} = \underline{\underline{622,3\text{V}}}$

b)  $U_{\text{mid}}(\frac{1}{2}) = \frac{2}{\pi} \cdot U_m = \frac{2}{\pi} \cdot 622,3\text{V} = \underline{\underline{396,1\text{V}}}$

$$U_{\text{mid}}(\frac{2}{2}) = \frac{2}{\pi} \cdot U_m + (-\frac{2}{\pi} \cdot U_m) = \underline{\underline{0\text{V}}}$$

$$U_{\text{mid}}(\frac{3}{2}) = \frac{2}{\pi} \cdot U_m \cdot \frac{1}{3} = \underline{\underline{132\text{V}}}$$

c)  $k_t = \frac{U_m}{U} = \frac{622,3\text{V}}{440\text{V}} = \underline{\underline{1,41}}$

d)  $k_{p(\frac{1}{2})} = \frac{U}{U_{\text{mid}}} = \frac{440\text{V}}{396\text{V}} = \underline{\underline{1,1}}$       $k_{p(\frac{2}{2})} = \frac{U}{U_{\text{mid}}} = \frac{440\text{V}}{0\text{V}} = \underline{\underline{(0)}}$

6.1.5

$$U_m = U \cdot \sqrt{2} = 200V \cdot \sqrt{2} = \underline{282,8V}$$

$$U_{(45^\circ)} = U_m \cdot \sin \alpha = 282,8V \cdot \sin 45^\circ = \underline{200V}$$

$$U_{(60^\circ)} = U_m \cdot \sin \alpha = 282,8V \cdot \sin 60^\circ = \underline{245V}$$

$$U_{(180^\circ)} = U_m \cdot \sin \alpha = 282,8V \cdot \sin 180^\circ = \underline{0}$$

$$U_{(230^\circ)} = U_m \cdot \sin \alpha = 282,8V \cdot \sin 230^\circ = \underline{-216,7V}$$

6.1.6

$$i_{(\frac{\pi}{4})} = I_m \cdot \sin \omega t = 125A \cdot \sin\left(\frac{\pi}{4}\right) = \underline{98,2A}$$

$$i_{(\frac{2\pi}{3})} = I_m \cdot \sin \omega t = 125A \cdot \sin\left(\frac{2\pi}{3}\right) = \underline{108,3A}$$

$$i_{(\pi)} = I_m \cdot \sin \omega t = 125A \cdot \sin \pi = \underline{0}$$

$$i_{(\frac{3\pi}{2})} = I_m \cdot \sin \omega t = 125A \cdot \sin\left(\frac{3\pi}{2}\right) = \underline{-125A}$$

6.1.7

$$U_m = U \cdot \sqrt{2} = 150V \cdot \sqrt{2} = \underline{212,1V}$$

(En periode T:

$$T = \frac{1}{f} = \frac{1}{50\text{Hz}} = \underline{0,02s} = \underline{20ms}$$

$$\frac{4ms}{20ms} = \frac{x}{360^\circ} \quad x = \frac{4ms \cdot 360^\circ}{20ms} = \underline{72^\circ}$$

$$U_{(4ms)} = U_m \cdot \sin \alpha = 212,1V \cdot \sin 72^\circ = \underline{201,7V}$$

eller;

$$U_{(4ms)} = U_m \cdot \sin 2 \cdot \pi \cdot f \cdot t = 212,1V \cdot \sin(2 \cdot \pi \cdot 50\text{Hz} \cdot 4 \cdot 10^{-3}s) = \underline{201,7V}$$

$$u_{(5ms)} = U_m \cdot \sin \omega t = 212,1 \text{ V} \cdot \sin(2 \cdot \pi \cdot 50 \text{ Hz} \cdot 5 \cdot 10^{-3} \text{ s}) = \underline{\underline{212,1 \text{ V}}}$$

$$u_{(7ms)} = U_m \cdot \sin \omega t = 212,1 \text{ V} \cdot \sin(2 \cdot \pi \cdot 50 \text{ Hz} \cdot 7 \cdot 10^{-3} \text{ s}) = \underline{\underline{171,6 \text{ V}}}$$

$$u_{(12ms)} = U_m \cdot \sin \omega t = 212,1 \text{ V} \cdot \sin(2 \cdot \pi \cdot 50 \text{ Hz} \cdot 12 \cdot 10^{-3} \text{ s}) = \underline{\underline{-124,7 \text{ V}}}$$

$$u_{(16ms)} = U_m \cdot \sin \omega t = 212,1 \text{ V} \cdot \sin(2 \cdot \pi \cdot 50 \text{ Hz} \cdot 16 \cdot 10^{-3} \text{ s}) = \underline{\underline{-201,7 \text{ V}}}$$

6.1.11

$$a) \quad \frac{x}{2\pi} = \frac{30^\circ}{360^\circ} \Rightarrow x = \frac{30^\circ \cdot 2 \cdot \pi}{360^\circ} = \underline{\underline{\frac{\pi}{6}}}$$

$$\frac{x}{2\pi} = \frac{40^\circ}{360^\circ} \Rightarrow x = \frac{40^\circ \cdot 2 \cdot \pi}{360^\circ} = \underline{\underline{\frac{2\pi}{9}}}$$

$$\frac{x}{2\pi} = \frac{60^\circ}{360^\circ} \Rightarrow x = \frac{60^\circ \cdot 2 \cdot \pi}{360^\circ} = \underline{\underline{\frac{\pi}{3}}}$$

$$\frac{x}{2\pi} = \frac{135^\circ}{360^\circ} \Rightarrow x = \frac{135^\circ \cdot 2 \cdot \pi}{360^\circ} = \underline{\underline{\frac{3\pi}{4}}}$$

$$b) \quad T = \frac{1}{f} = \frac{1}{60 \text{ Hz}} = 0,0167 \text{ s} = \underline{\underline{16,7 \text{ ms}}}$$

$$\frac{x}{16,7 \cdot 10^{-3} \text{ s}} = \frac{30^\circ}{360^\circ} \Rightarrow x = \frac{30^\circ \cdot 16,7 \cdot 10^{-3} \text{ s}}{360^\circ} = \underline{\underline{1,39 \cdot 10^{-3} \text{ s}}} = \underline{\underline{1,39 \text{ ms}}}$$

$$\frac{x}{16,7 \cdot 10^{-3} \text{ s}} = \frac{40^\circ}{360^\circ} \Rightarrow x = \frac{40^\circ \cdot 16,7 \cdot 10^{-3} \text{ s}}{360^\circ} = \underline{\underline{1,85 \cdot 10^{-3} \text{ s}}} = \underline{\underline{1,85 \text{ ms}}}$$

$$\frac{x}{16,7 \cdot 10^{-3} \text{ s}} = \frac{60^\circ}{360^\circ} \Rightarrow x = \frac{60^\circ \cdot 16,7 \cdot 10^{-3} \text{ s}}{360^\circ} = \underline{\underline{2,78 \cdot 10^{-3} \text{ s}}} = \underline{\underline{2,78 \text{ ms}}}$$

$$\frac{x}{16,7 \cdot 10^{-3} \text{ s}} = \frac{135^\circ}{360^\circ} \Rightarrow x = \frac{135^\circ \cdot 16,7 \cdot 10^{-3} \text{ s}}{360^\circ} = \underline{\underline{6,25 \cdot 10^{-3} \text{ s}}} = \underline{\underline{6,25 \text{ ms}}}$$

6.1.12

4

$$a) \frac{x}{360^\circ} = \frac{\frac{\pi}{6}}{2\pi} \Rightarrow x = \frac{\frac{\pi}{6} \cdot 360^\circ}{2\pi} = \underline{\underline{30^\circ}}$$

$$\frac{x}{360^\circ} = \frac{\frac{\pi}{5}}{2\pi} \Rightarrow x = \frac{\frac{\pi}{5} \cdot 360^\circ}{2\pi} = \underline{\underline{36^\circ}}$$

$$\frac{x}{360^\circ} = \frac{\frac{3\pi}{4}}{2\pi} \Rightarrow x = \frac{\frac{3\pi}{4} \cdot 360^\circ}{2\pi} = \underline{\underline{135^\circ}}$$

$$\frac{x}{360^\circ} = \frac{\frac{5\pi}{2}}{2\pi} \Rightarrow x = \frac{\frac{5\pi}{2} \cdot 360^\circ}{2\pi} = \underline{\underline{450^\circ}}$$

$$b) T = \frac{1}{f} = \frac{1}{60 \text{ Hz}} = 0,0167 \text{ s} = \underline{\underline{16,7 \text{ ms}}}$$

$$\frac{x}{16,7 \cdot 10^{-3} \text{ s}} = \frac{\frac{\pi}{6}}{2\pi} \Rightarrow x = \frac{\frac{\pi}{6} \cdot 16,7 \cdot 10^{-3} \text{ s}}{2\pi} = \underline{\underline{1,39 \text{ ms}}}$$

$$\frac{x}{16,7 \cdot 10^{-3} \text{ s}} = \frac{\frac{\pi}{5}}{2\pi} \Rightarrow x = \frac{\frac{\pi}{5} \cdot 16,7 \cdot 10^{-3} \text{ s}}{2\pi} = \underline{\underline{1,67 \text{ ms}}}$$

$$\frac{x}{16,7 \cdot 10^{-3} \text{ s}} = \frac{\frac{3\pi}{4}}{2\pi} \Rightarrow x = \frac{\frac{3\pi}{4} \cdot 16,7 \cdot 10^{-3} \text{ s}}{2\pi} = \underline{\underline{6,25 \text{ ms}}}$$

$$\frac{x}{16,7 \cdot 10^{-3} \text{ s}} = \frac{\frac{5\pi}{2}}{2\pi} \Rightarrow x = \frac{\frac{5\pi}{2} \cdot 16,7 \cdot 10^{-3} \text{ s}}{2\pi} = \underline{\underline{20,8 \text{ ms}}}$$

6.1.13

$$T = \frac{1}{f} = \frac{1}{50 \text{ Hz}} = 0,02 \text{ s} = \underline{\underline{20 \text{ ms}}}$$

a)

$$\frac{X}{360^\circ} = \frac{1,67 \cdot 10^{-3} \text{ s}}{20 \cdot 10^{-3} \text{ s}} \Rightarrow X = \frac{1,67 \cdot 10^{-3} \text{ s} \cdot 360^\circ}{20 \cdot 10^{-3} \text{ s}} = \underline{\underline{30^\circ}}$$

$$X = \frac{2,5 \cdot 10^{-3} \text{ s} \cdot 360^\circ}{20 \cdot 10^{-3} \text{ s}} = \underline{\underline{45^\circ}}$$

$$X = \frac{5 \cdot 10^{-3} \text{ s} \cdot 360^\circ}{20 \cdot 10^{-3} \text{ s}} = \underline{\underline{90^\circ}}$$

$$X = \frac{8 \cdot 10^{-3} \text{ s} \cdot 360^\circ}{20 \cdot 10^{-3} \text{ s}} = \underline{\underline{144^\circ}}$$

$$X = \frac{19 \cdot 10^{-3} \text{ s} \cdot 360^\circ}{20 \cdot 10^{-3} \text{ s}} = \underline{\underline{342^\circ}}$$

b)

$$\frac{X}{2\pi} = \frac{1,67 \cdot 10^{-3} \text{ s}}{20 \cdot 10^{-3} \text{ s}} \Rightarrow X = \frac{1,67 \cdot 10^{-3} \text{ s} \cdot 2 \cdot \pi}{20 \cdot 10^{-3} \text{ s}} = \underline{\underline{0,525}}$$

$$X = \frac{2,5 \cdot 10^{-3} \text{ s} \cdot 2 \cdot \pi}{20 \cdot 10^{-3} \text{ s}} = \underline{\underline{0,785}}$$

$$X = \frac{5 \cdot 10^{-3} \text{ s} \cdot 2 \cdot \pi}{20 \cdot 10^{-3} \text{ s}} = \underline{\underline{1,57}}$$

$$X = \frac{8 \cdot 10^{-3} \text{ s} \cdot 2 \cdot \pi}{20 \cdot 10^{-3} \text{ s}} = \underline{\underline{2,51}}$$

$$X = \frac{19 \cdot 10^{-3} \text{ s} \cdot 2 \cdot \pi}{20 \cdot 10^{-3} \text{ s}} = \underline{\underline{5,97}}$$