Queensland University of Technology

EGB241

Electromagnetics and Machines

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Contents

Chapter 1

Alternating Current

1.1 AC Signals

- Direct Current: DC has polarity (direction) which stays the same. Amplitude may vary, but charge always flows in the same direction
- Alternating Current: Voltage polarity and current direction reverses periodically
- Period: Length of time (seconds) for one repetition of a cycle
- Frequency: $f = \frac{1}{T}$ [Hz]

1.2 Sine Wave

In its purest form, AC signals are sine waves, for example:
$v(t) = V_o \sin(2\pi f t) = V_o \sin(\omega t)$ Any AC wave that consists of only one frequency is sinusoidal
Utility AC is a sine wave with frequency 50Hz

1.3 Amplitude of an AC wave

- Peak Amplitude (V_p): Maximum positive deviation
- Peak-to-Peak Amplitude (V_{p-p}): Net difference between positive and negative peak amplitude

$$V_{p-p} = 2 \times V_p \tag{1.1}$$

Figure 1.1: Peak to Peak Amplitude

- Root-Mean-Square Amplitude (V_{rms}): Effective amplitude of a sinusoidal AC wave. Average power dissipated in a resistor with an AC voltage = power dissipated with DC voltage of V_{rms}
  $V_{rms} \leq V_p \forall$ AC Waves

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T v^2(t)dt} = \sqrt{\frac{1}{T}\int_\alpha^{T+\alpha} v^2(t)dt} \tag{1.2}$$

Figure 1.2: RMS Amplitude

Sinusoidal AC Wave	$V_{rms} = \frac{V_o}{\sqrt{2}} \approx 0.707V_o$
Square Ac Wave	$V_{rms} = V_p$
Triangular Wave	$V_{rms} = \frac{V_o}{\sqrt{3}} \approx 0.577V_o$

Figure 1.3: AC RMS Values

1.4 Phase Shifting

$f(x+\alpha)$ is a horizontal translation of $f(x)$
Where:

If $a > 0$, $f(x)$ is shifted to the left
If $a < 0$, $f(x)$ is shifted to the right

If $v_1(t) = V_o \sin(\omega t)$, then $v_2 = V_o \sin(\omega t + \phi) = V_o \sin\left[\omega\left(t + \frac{\phi}{\omega}\right)\right]$ is a shifted version of $v_1(t)$ by $\frac{\phi}{\omega}$ seconds to the left (where ϕ is in radians and positive)
$\mathrm{v}_2(t)$ leads $v_1(t)$ by ϕ radians ($180 \times \frac{\phi}{\pi}$ degrees)
$v_1(t)$ lags $v_2(t)$ by ϕ radians ($180 \times \frac{\phi}{\pi}$ degrees)

List of Figures