Universidad
Carlos III de Madrid
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Session 1
Introduction to electronic circuits and signals

Electronic Components and Circuits

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1. Electronic Signals

Parameters of the electric signals

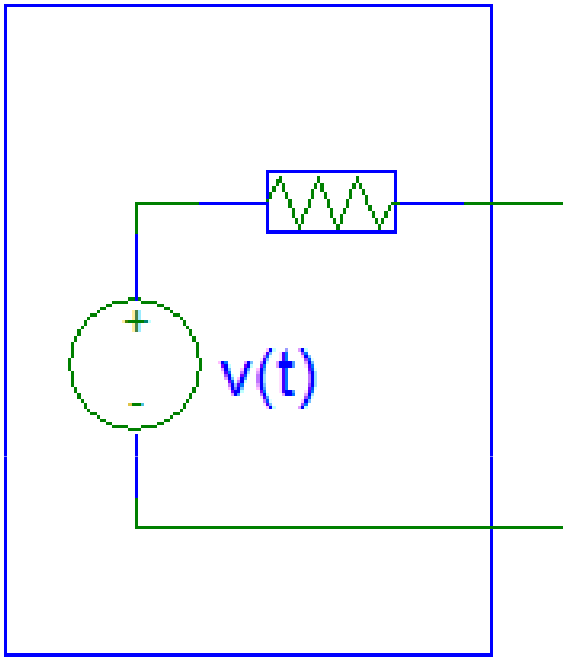
- Introduction and types of signals
- Definitions of statistical parameters
  - Mean value (Continuous , DC)
  - Root mean square (RMS) / Mean square
- Power
  - Instantaneous Power
  - Mean Dissipated Power
- Useful examples

Introduction and Types of Signals

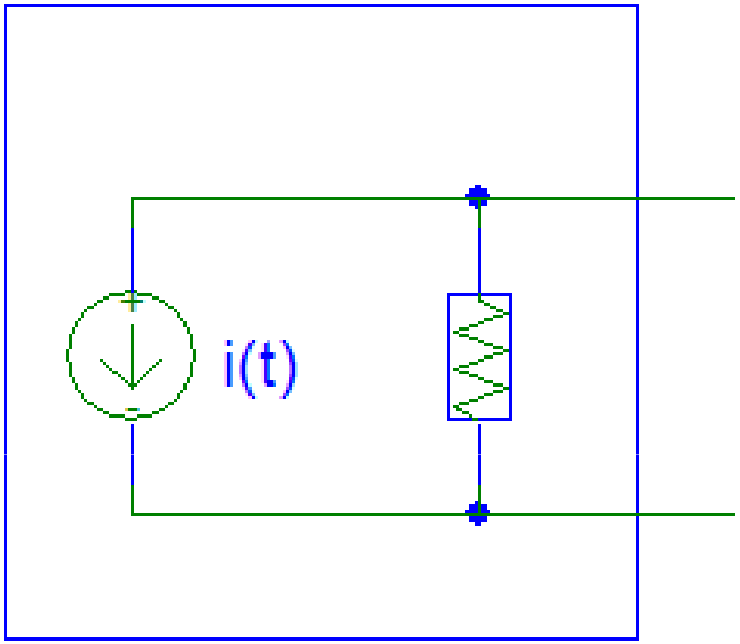
- Types
  - Static (Continuous DC)
  - Dynamics
    - Deterministic
      - Periodicals
- Analysis
  - Total signal: Why the RMS?
    - Continuous component (DC): Mean
    - Pure alternating component (AC): DC subtracted

Signals: voltage and current

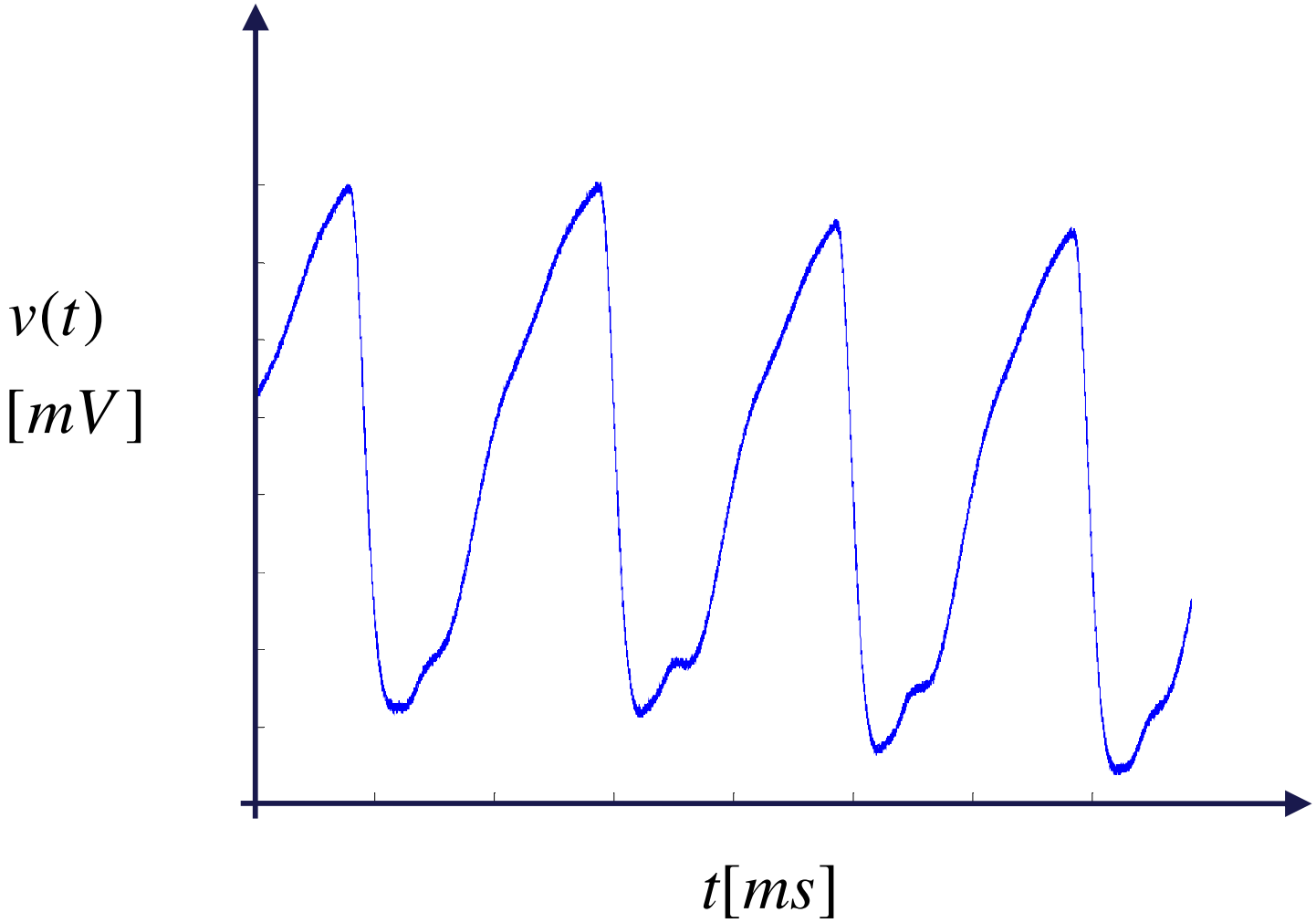
Equivalent voltage source



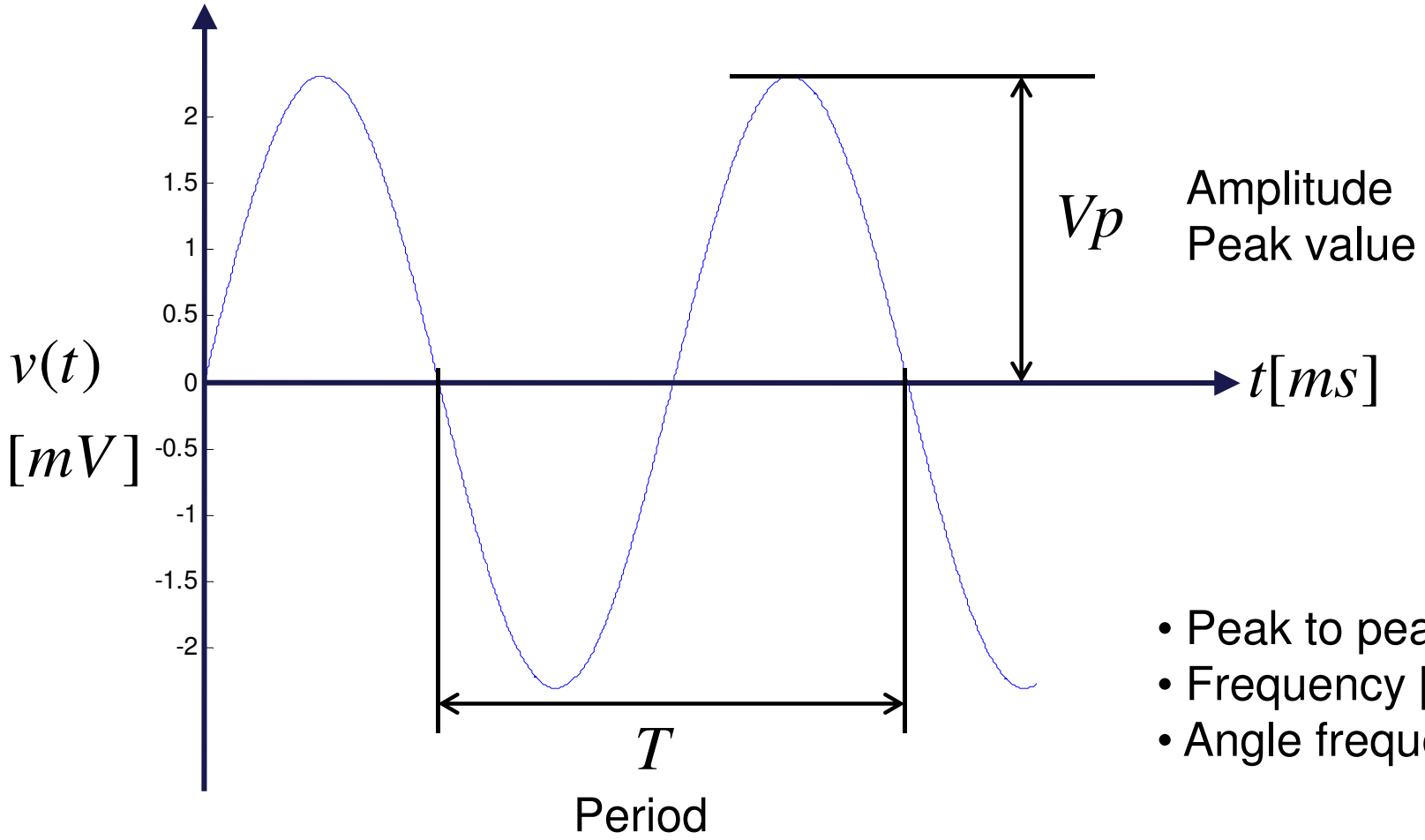
Equivalent current source



Representation in time

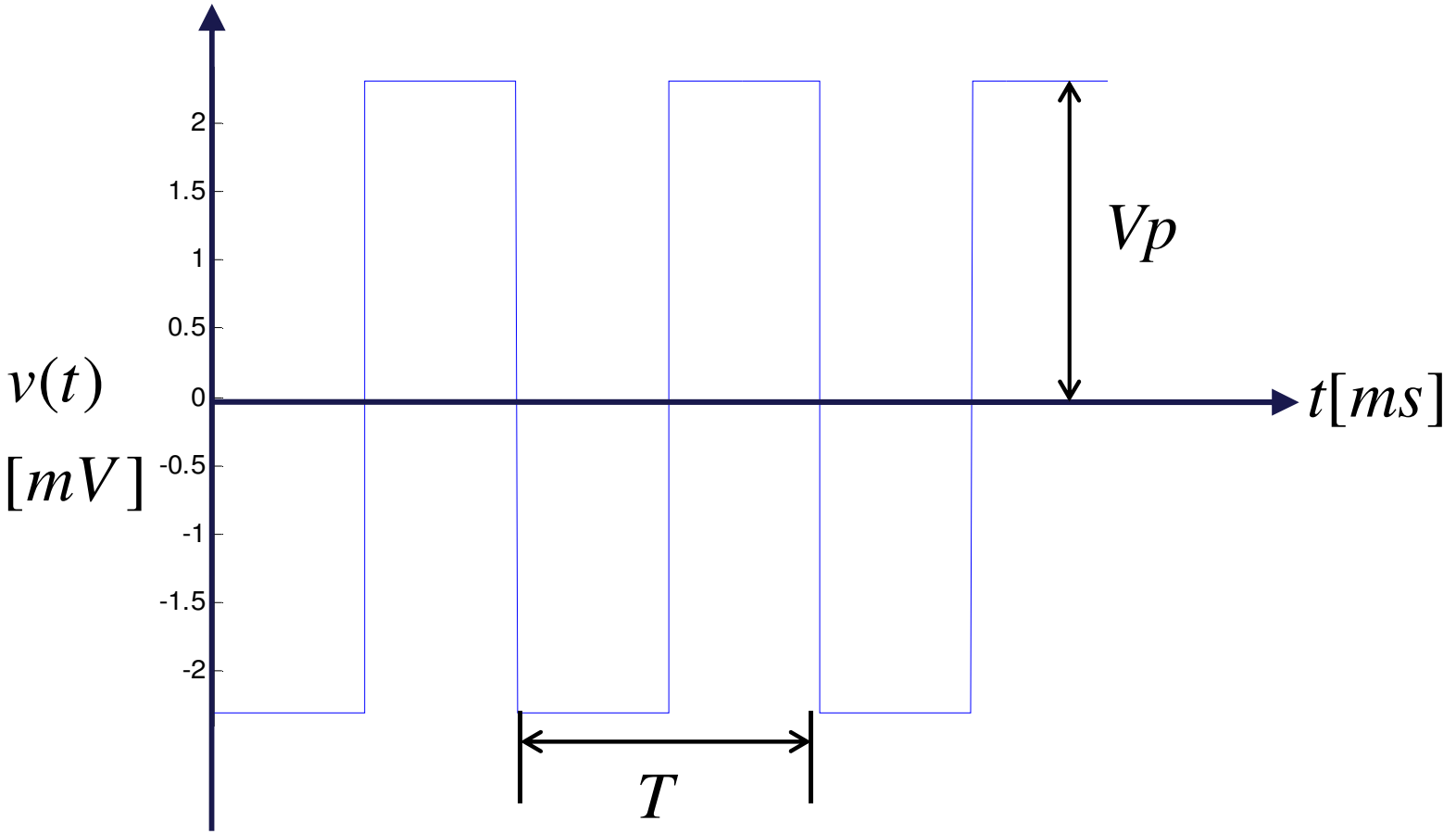


Sinusoidal Signal



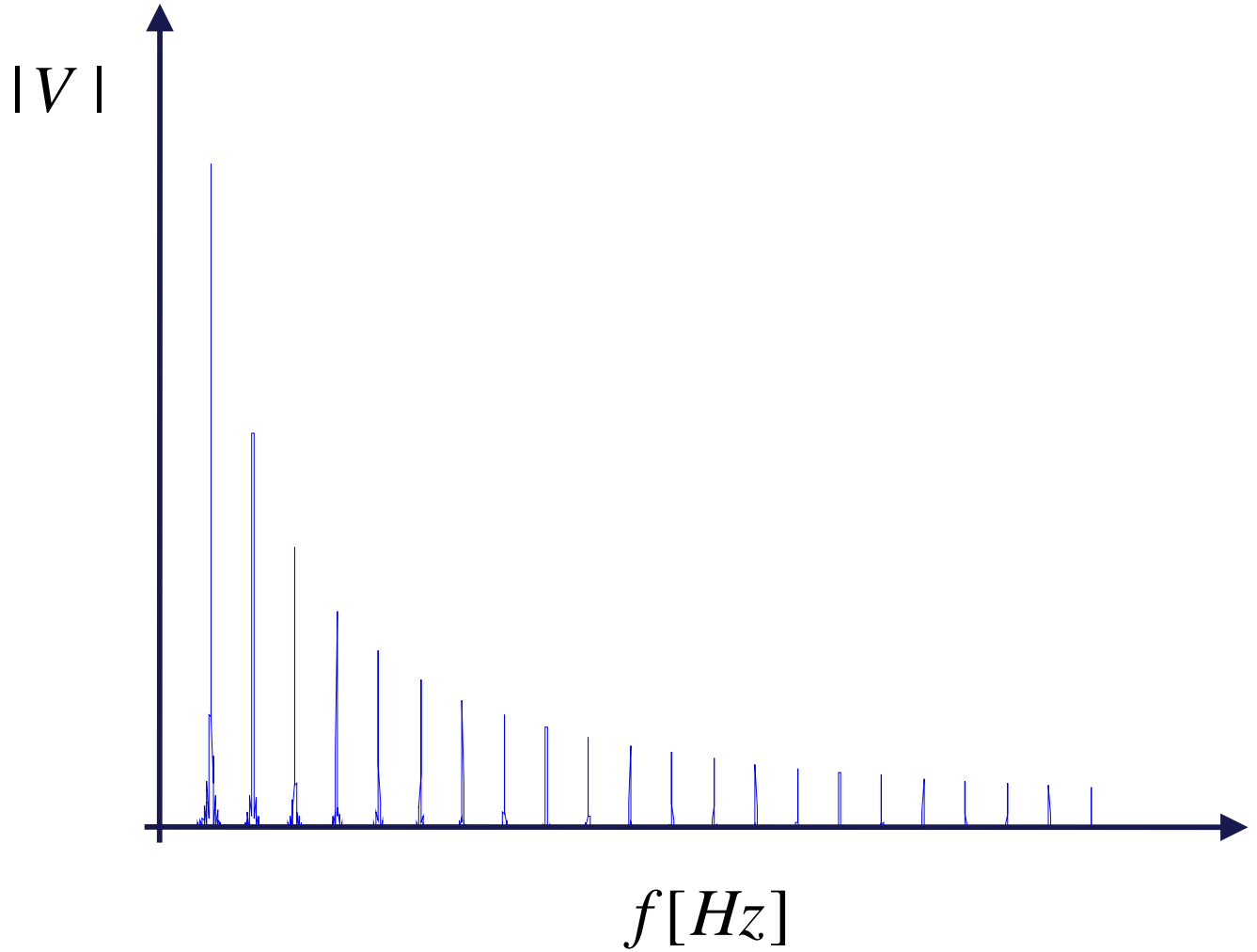
- Peak to peak value?
- Frequency [Hz]?
- Angle frequency?

Square signal



Repetition period

Frequency representation



Definitions

- Mean (DC)

$$Vm = \frac{1}{t_2 - t_1}\int_{t_1}^{t_2} v(t)dt$$

$$Vm = \frac{1}{T}\int_{0}^{T} v(t)dt$$

- RMS

$$V_{RMS} = \sqrt{\frac{1}{T}\int_{0}^{T} [v(t)]^2 dt}$$

$$V_{RMS}{}^2 = Vmean - square$$

- Instantaneous power

$$P_i(t) = v(t) \cdot i(t)$$

- Mean power

$$P_m = \frac{1}{T}\int_{0}^{T} P_i(t)dt = \frac{1}{T}\int_{0}^{T} v(t) \cdot i(t)dt$$

Average dissipated power

$$P_D = \frac{1}{T}\int_0^T R \cdot i^2(t)dt = \frac{1}{T}\int_0^T \frac{v^2(t)}{R}dt$$

$$P_D = R \cdot {I_{RMS}}^2 = \frac{{V_{RMS}}^2}{R}$$

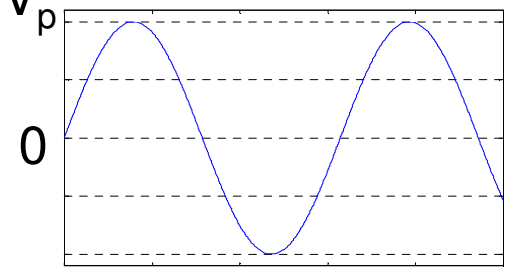
$$V_{RMS} = \sqrt{\frac{1}{T}\int_0^T [v(t)]^2 dt}$$

$$I_{RMS} = \sqrt{\frac{1}{T}\int_0^T [i(t)]^2 dt}$$

$$P_D = P_{D-DC} + P_{D-AC} = R \cdot (I_{DC}^2 + I_{AC-RMS}^2) = \frac{V_{DC}^2 + V_{AC-RMS}^2}{R}$$

Examples

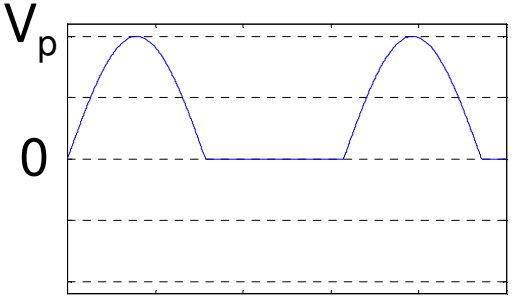
- Sinusoidal



$$V_m = 0$$

$$V_{RMS} = \frac{V_p}{\sqrt{2}}$$

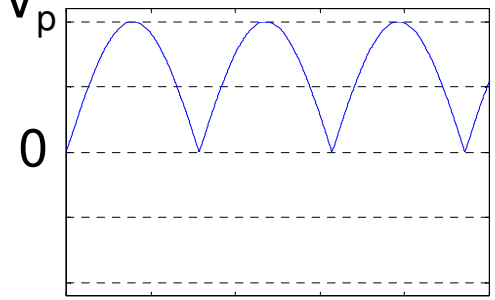
- Half-wave rectified



$$V_m = \frac{V_p}{\pi}$$

$$V_{RMS} = \frac{V_p}{2\sqrt{2}}$$

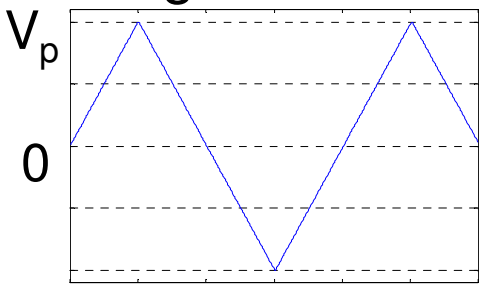
- Full-wave rectified



$$V_m = \frac{2V_p}{\pi}$$

$$V_{RMS} = \frac{V_p}{\sqrt{2}}$$

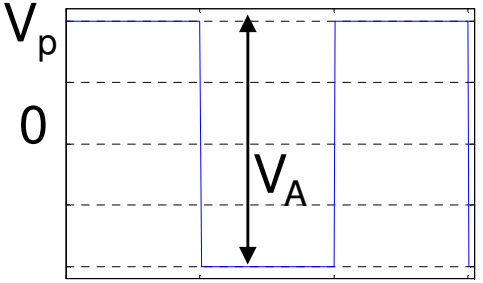
- Triangular



$$V_m = 0$$

$$V_{RMS} = \frac{V_p}{\sqrt{3}}$$

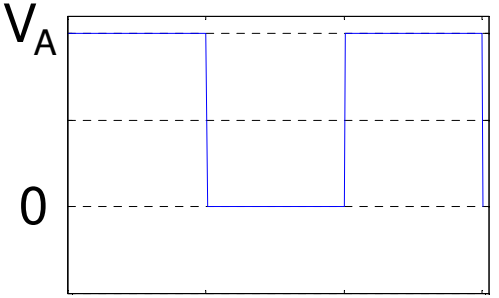
- Square



$$V_m = 0$$

$$V_{RMS} = \frac{V_A}{2} = V_p$$

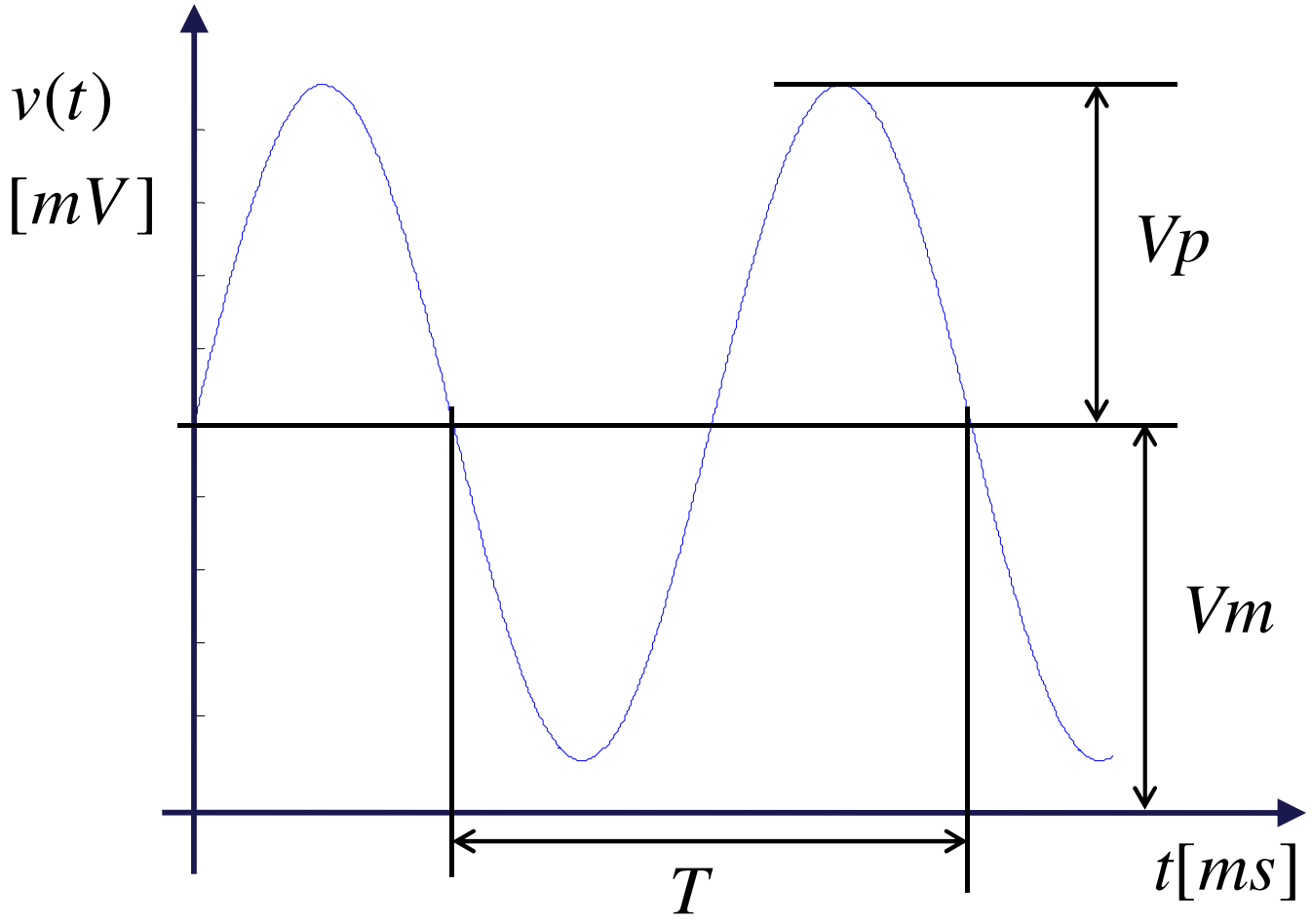
- Positive pulses



$$V_m = \frac{V_A}{2}$$

$$V_{RMS} = \frac{V_A}{\sqrt{2}}$$

Exercise



Substitute values:
- Vp = 100 mV
- Vm = 120 mV
- R = 1 KΩ
- f = 10 kHz

Substitute values:
- Vp = 10 V
- Vm = 12 V
- R = 100 Ω
- f = 50 Hz

- RMS value of the full signal?
- Total power dissipated in a resistance R?