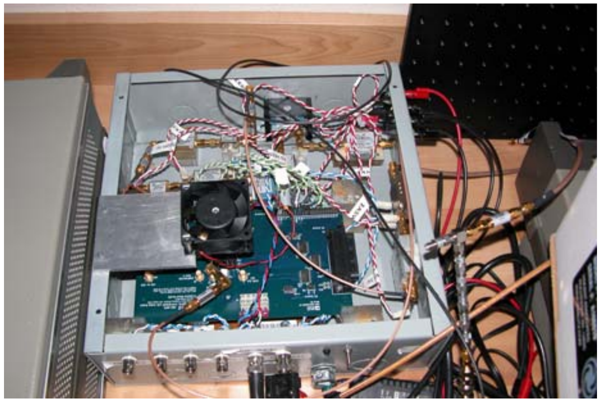
Summer Research

- Research is fun … and it pays.
- Most physics summer research involves electronics.
- The following fellowships are available:

  Charles Center Summer Scholarships
  Cummings Memorial Summer Scholarship in the Sciences
  Dintersmith Fellowships
  Chappell Undergraduate Research Fellowships
  REU (NSF): Research Experience for Undergraduates



- Scholarships/grants typically provide ~$3k + housing.
- Deadline: ***March 13, 2007.***

Benefits:

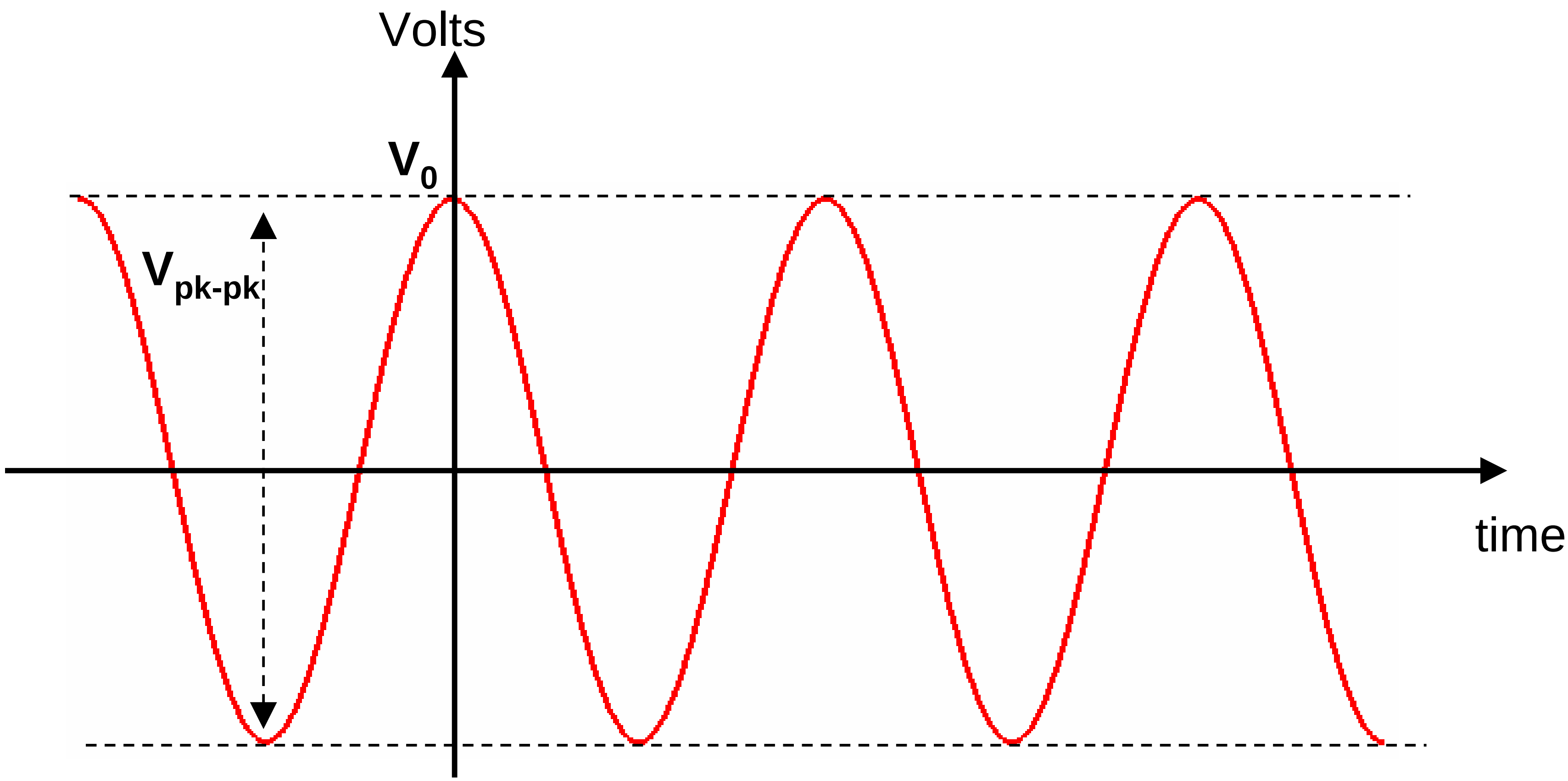
- Good way to see what sort of Physics is interesting to you.
- Good preparation for grad school.
- Looks good on applications/CV.

More info at: http://www.wm.edu/scholarships/summeropps.php

VIRGINIA MICROELECTRONICS CONSORTIUM (VMEC)
2008 SCHOLARS PROGRAM

- Virginia's best summer research program in microelectronics
- May – August, 2008
- VMEC has rapidly growing research and education opportunities in the field of microelectronics.
- If you are currently a junior or senior in a 4-year degree program at a university in Virginia, you are eligible to join us for a summer program that will give you a hands-on, state-of-the-art research experience.
- The VMEC internship provides excellent technical knowledge as well as industrial and academic contacts for your career development.
- **Deadline: February 11, 2008.**
- More info at http://people.virginia.edu/~lrh8t/vmec.htm

AC Signals



RMS definitions:

$$V_{RMS} = \sqrt{\left\langle V(t)^2 \right\rangle} = V_0 / \sqrt{2}$$

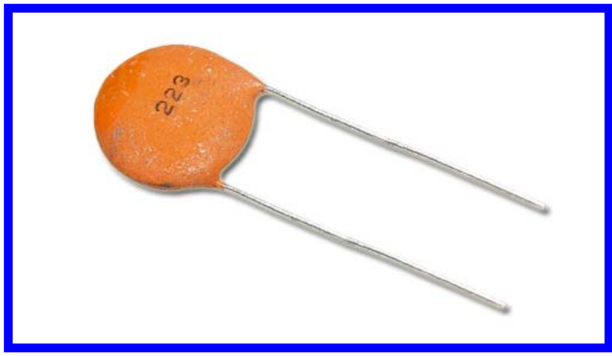
$$I_{RMS} = \sqrt{\left\langle I(t)^2 \right\rangle} = I_0 / \sqrt{2}$$

Power: $\boxed{P(t) = V(t) \cdot I(t)}$

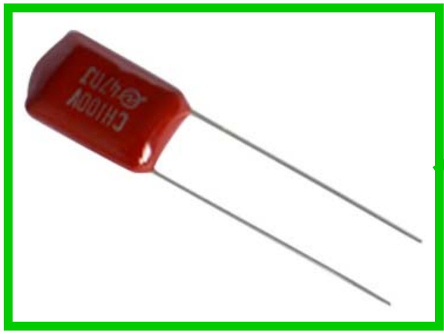
For a resistive AC circuit:

$$\left\langle P \right\rangle = I_{RMS} V_{RMS} = \frac{I_0 V_0}{2}$$

Capacitors



[Image from www.tedss.com]



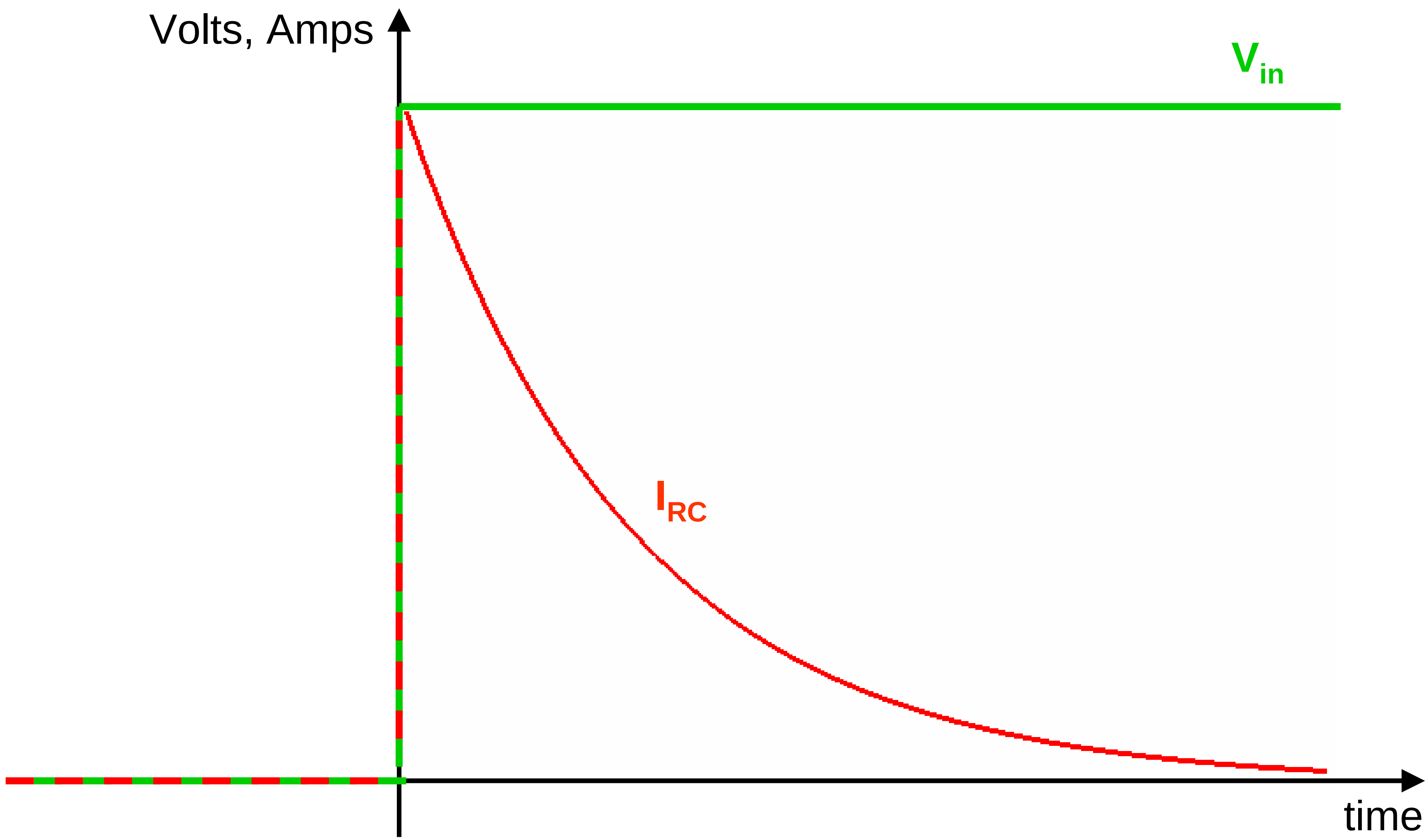
[Image from img.alibaba.com]

[Image from www.tedss.com]

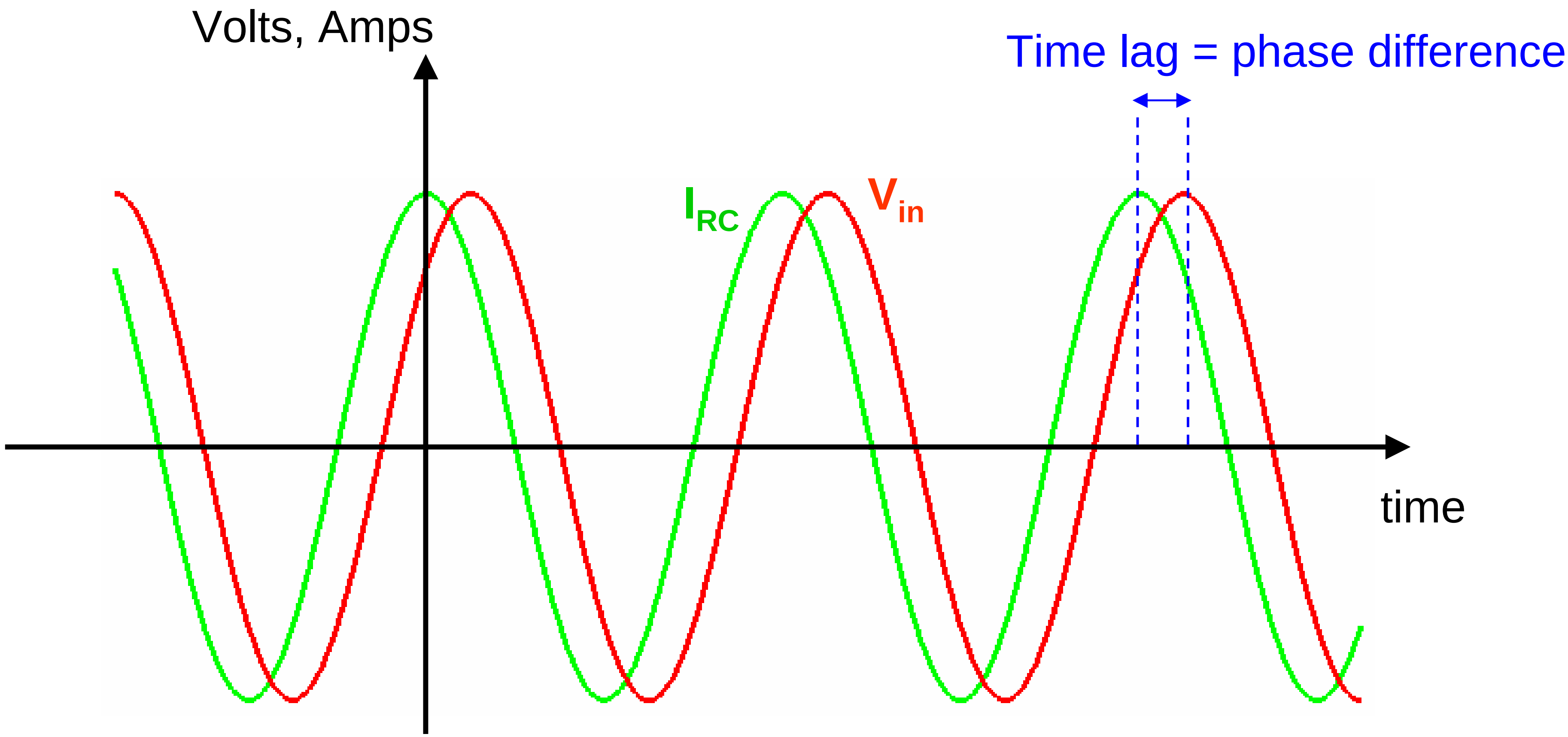
Type	Capacitance range	Maximum voltage	Accuracy	Temperature stability	Leakage	Comments
Mica	1pF–0.01μF	100–600	Good		Good	Excellent; good at RF
Tubular ceramic	0.5pF–100pF	100–600		Selectable		Several tempcos (including zero)
Ceramic	10pF–1μF	50–30,000	Poor	Poor	Moderate	Small, inexpensive, very popular
Polyester (Mylar)	0.001μF–50μF	50–600	Good	Poor	Good	Inexpensive, good, popular
Polystyrene	10pF–2.7μF	100–600	Excellent	Good	Excellent	High quality, large; signal filters
Polycarbonate	100pF–30μF	50–800	Excellent	Excellent	Good	High quality, small
Polypropylene	100pF–50μF	100–800	Excellent	Good	Excellent	High quality, low dielectric absorption
Teflon	1000pF–2μF	50–200	Excellent	Best	Best	High quality, lowest dielectric absorption
Glass	10pF–1000pF	100–600	Good		Excellent	Long-term stability
Porcelain	100pF–0.1μF	50–400	Good	Good	Good	Good long-term stability
Tantalum	0.1μF–500μF	6–100	Poor	Poor		High capacitance; polarized, small; low inductance
Electrolytic	0.1μF–1.6F	3–600	Terrible	Ghastly	Awful	Power-supply filters; polarized; short life
Double layer	0.1F–10F	1.5–6	Poor	Poor	Good	Memory backup; high series resistance
Oil	0.1μF–20μF	200–10,000			Good	High-voltage filters; large, long life
Vacuum	1pF–5000pF	2000–36,000			Excellent	Transmitters

(table from Horowitz and Hill, 1999)

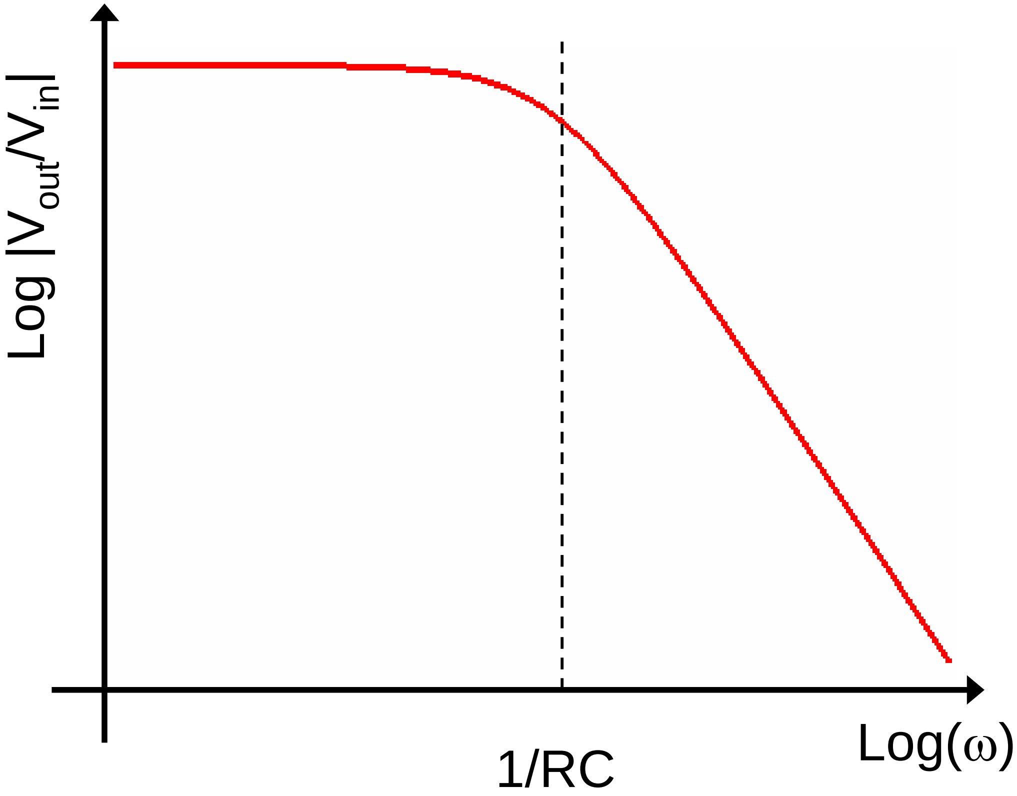
RC circuit: "DC" response

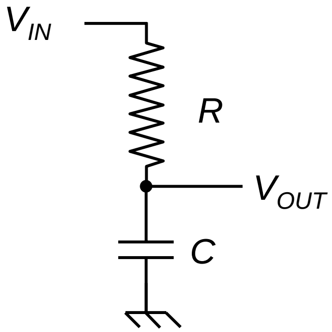


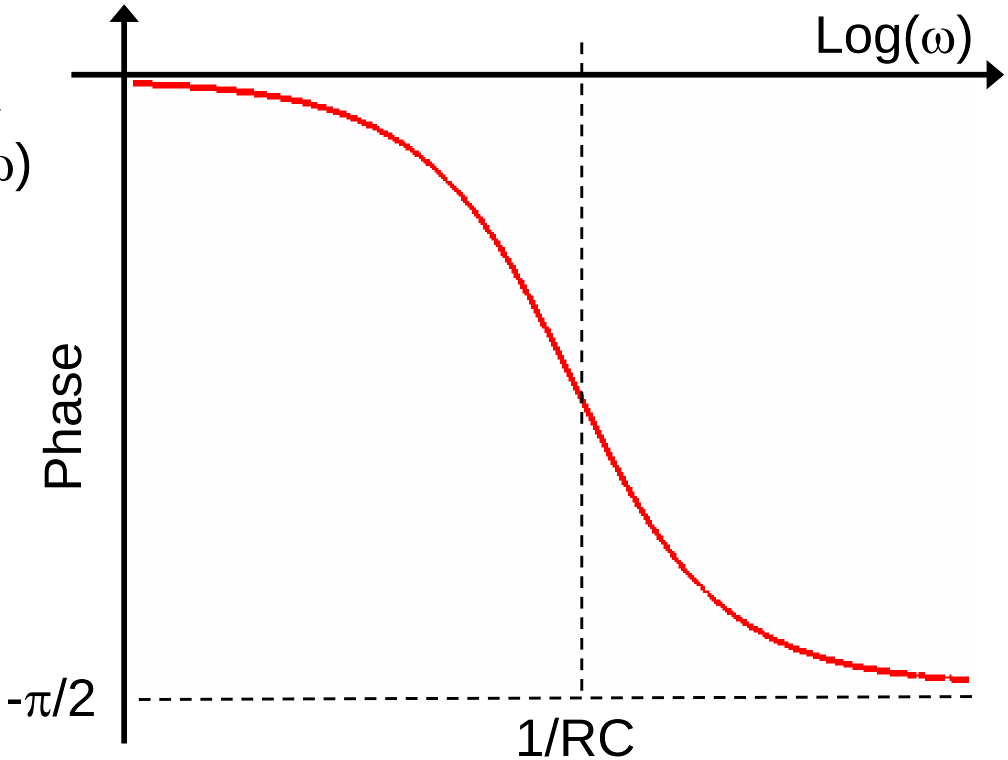
RC circuit: "AC" response



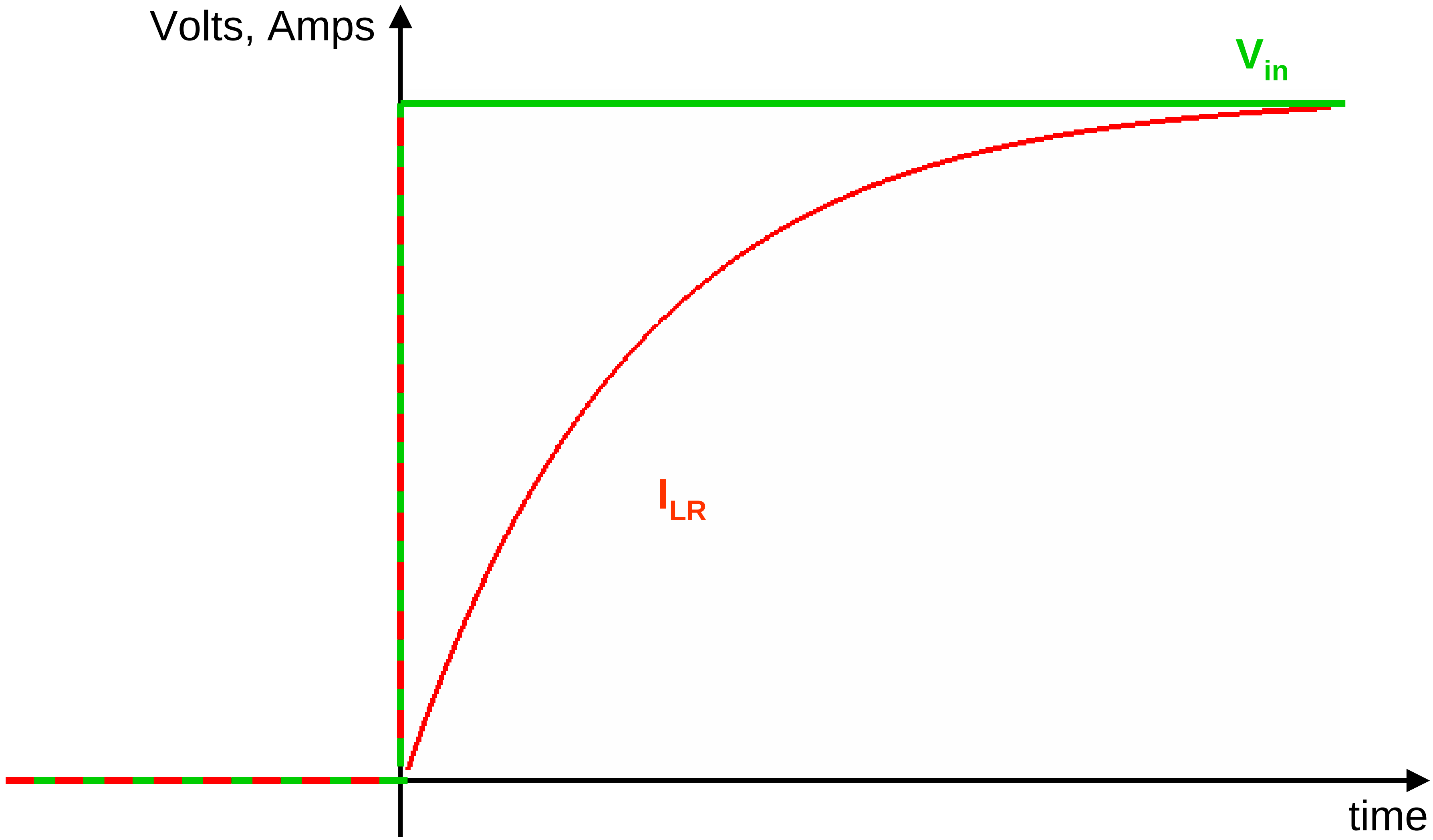
RC circuit: "AC" output performance



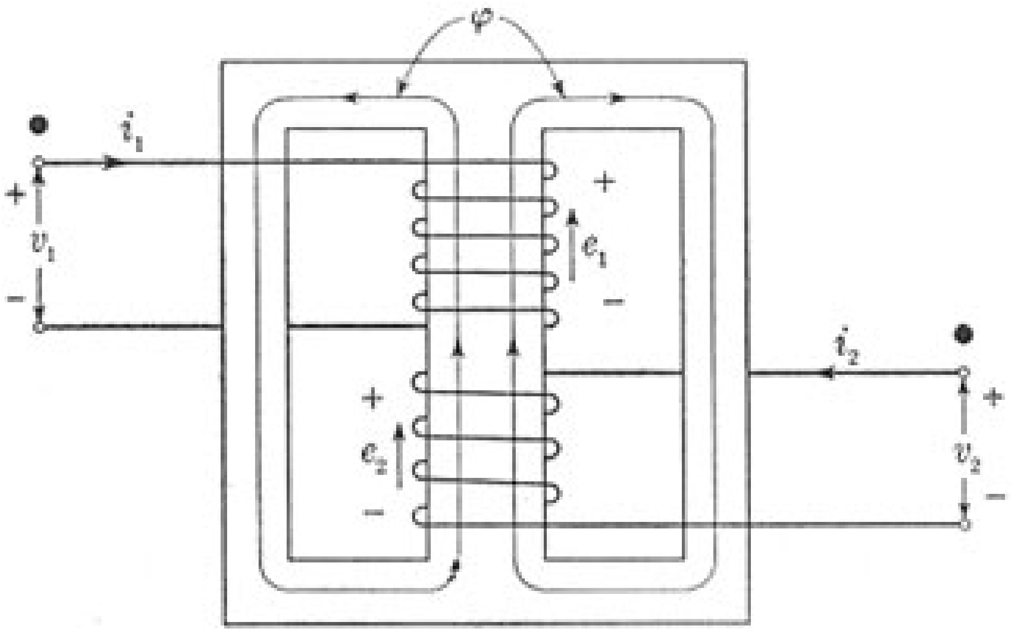




LR circuit: "DC" response



Transformers



[Diagram from www.obsoleteelectronics.com]

Transformer ratios obey the relation:

$$\boxed{\frac{V_p}{V_S} = \frac{N_P}{N_S} = \frac{I_S}{I_p}}$$

[image from www.ablecoil.com]

Conservation of Energy:

$$P_p = I_p V_p \geq P_S = I_S V_S$$

Transformers modify the impedance of an AC signal:

$$\frac{Z_p}{Z_S} = \left(\frac{N_P}{N_S}\right)^2$$