

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 20, 2009.**

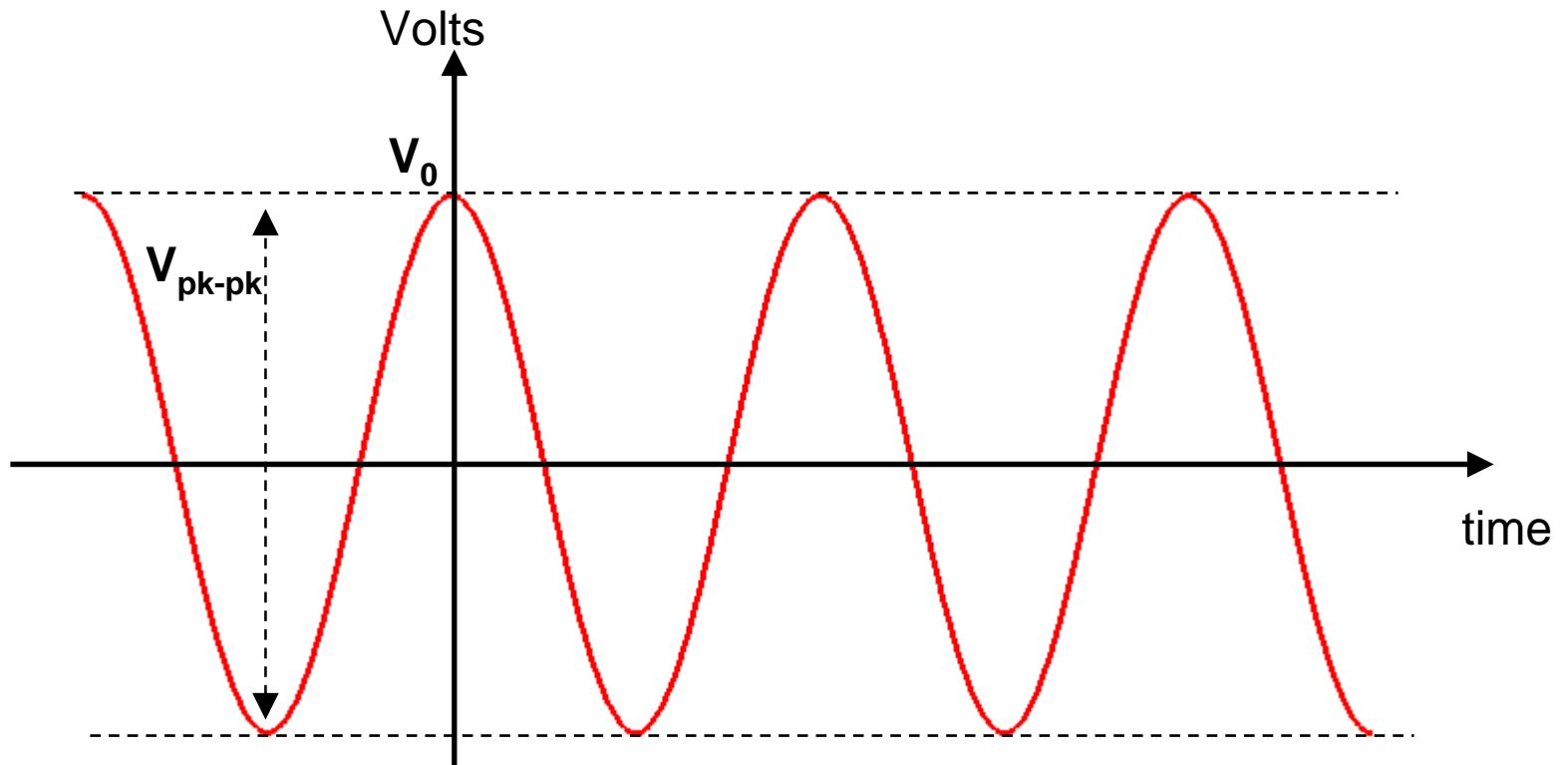
Benefits:

- 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>
<http://physics.wm.edu/~inovikova/StudentResearch/SummerResearch.htm>



AC Signals



RMS definitions:

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

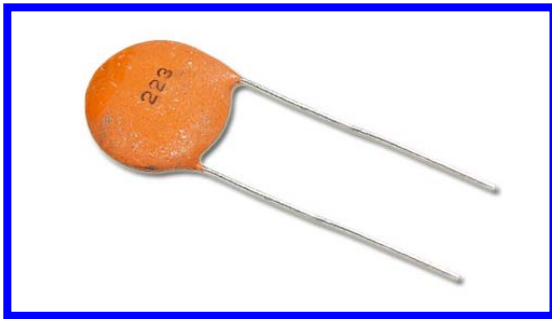
$$I_{RMS} = \sqrt{\langle I(t)^2 \rangle} = I_0 / \sqrt{2}$$

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

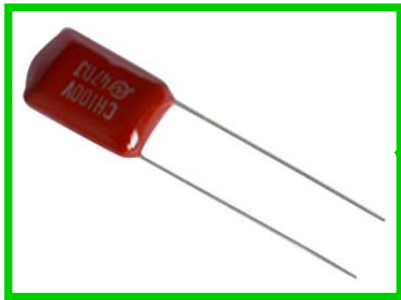
For a resistive AC circuit:

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

Capacitors



[Image from www.tedss.com]



[Image from img.alibaba.com]

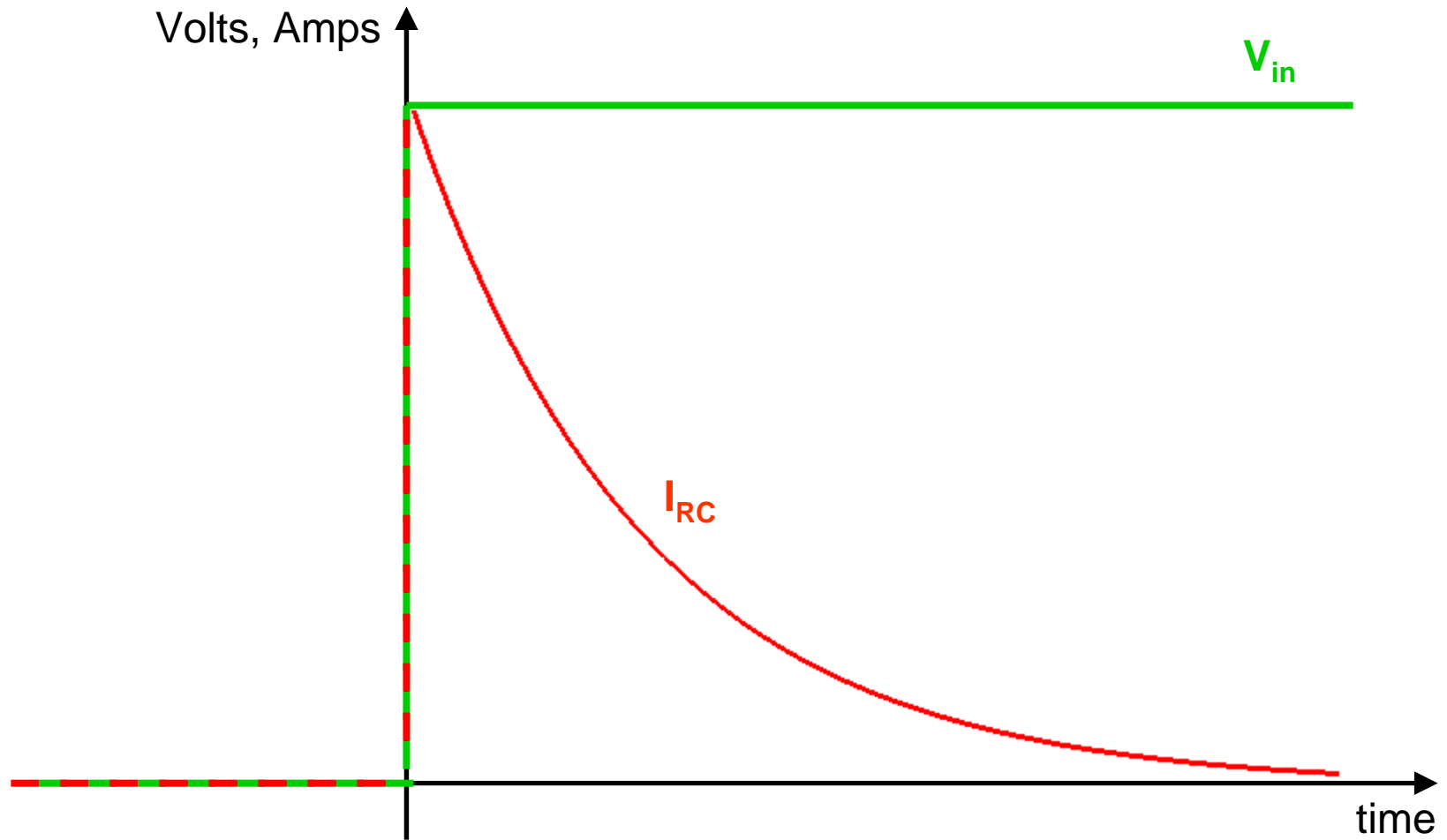


[Image from www.tedss.com]

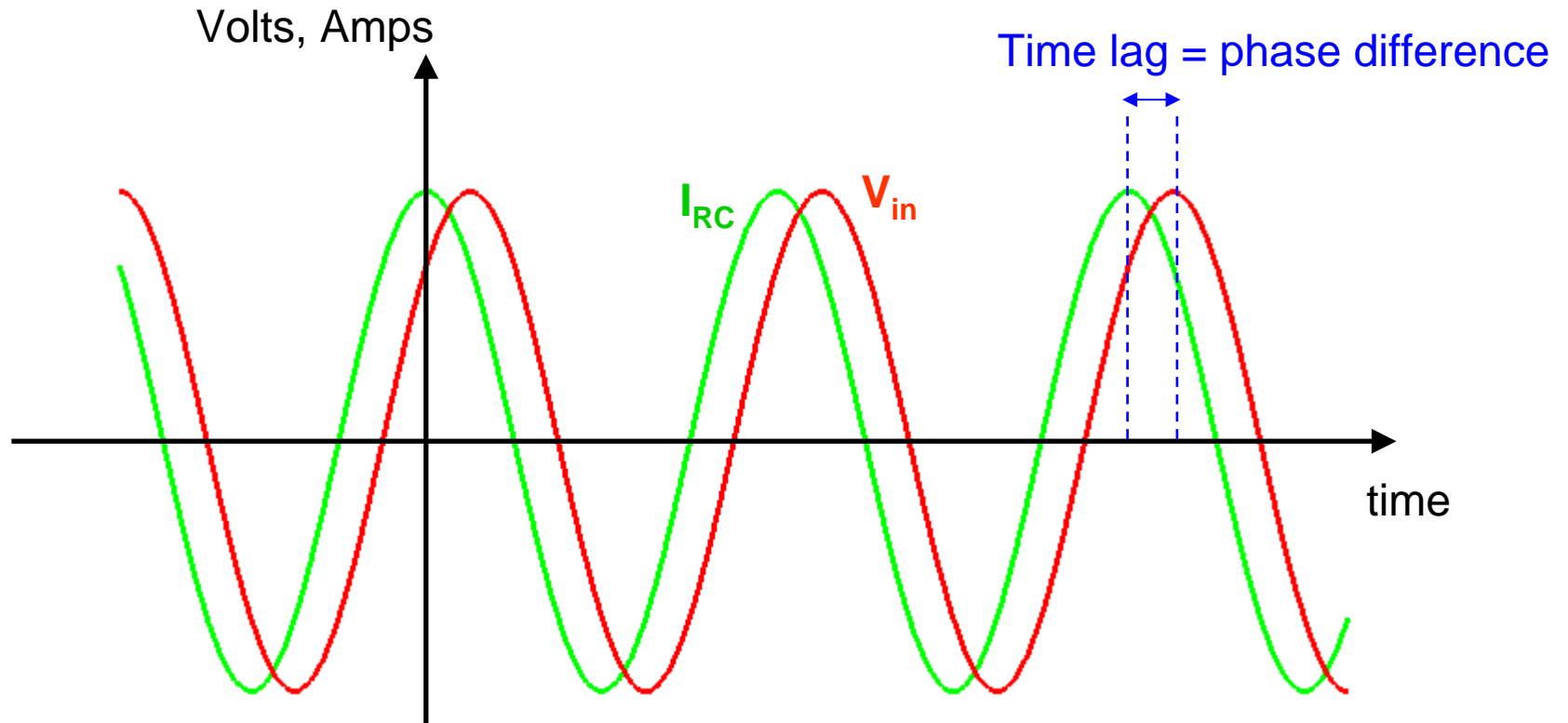
Type	Capacitance range	Maximum voltage	Accuracy	Temperature stability	Leakage	Comments
Mica	1pF–0.01 μ F	100–600	Good		Good	Excellent; good at RF
Tubular ceramic	0.5pF–100pF	100–600		Selectable		Several tempcos (including zero)
Ceramic	10pF–1 μ F	50–30,000	Poor	Poor	Moderate	Small, inexpensive, very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

(table from Horowitz and Hill, 1999)

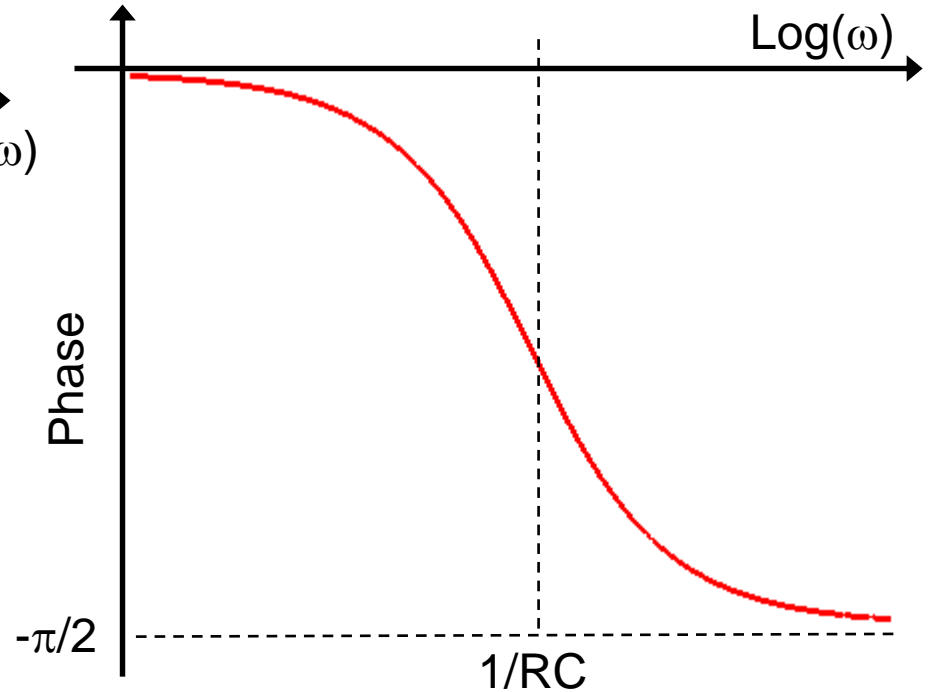
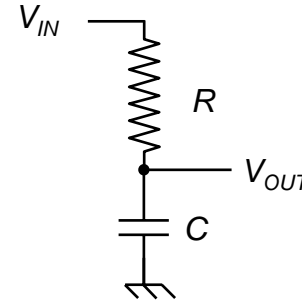
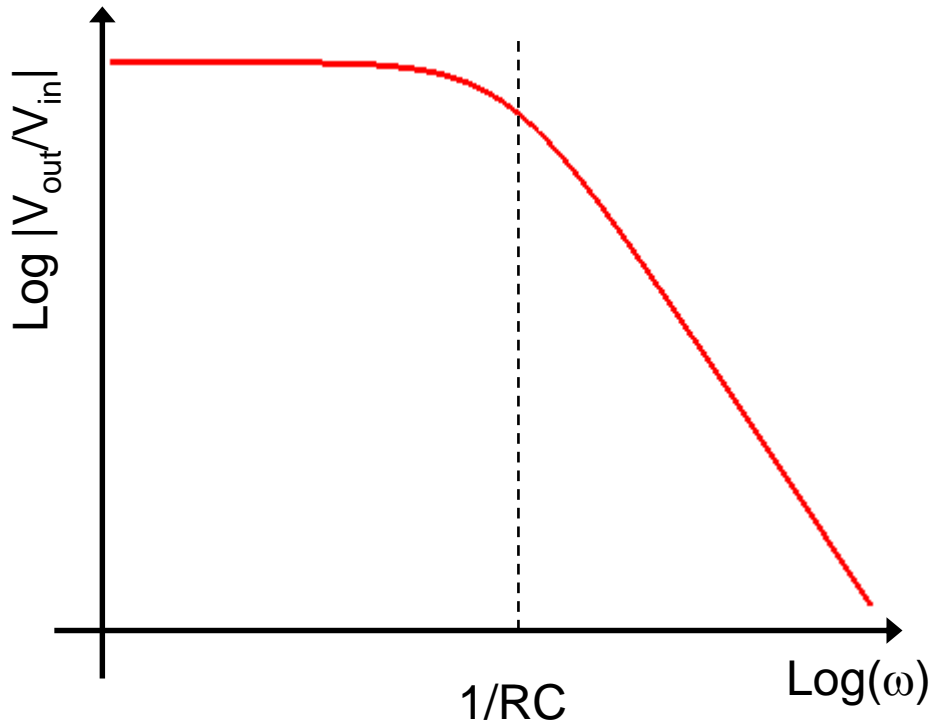
RC circuit: "DC" response



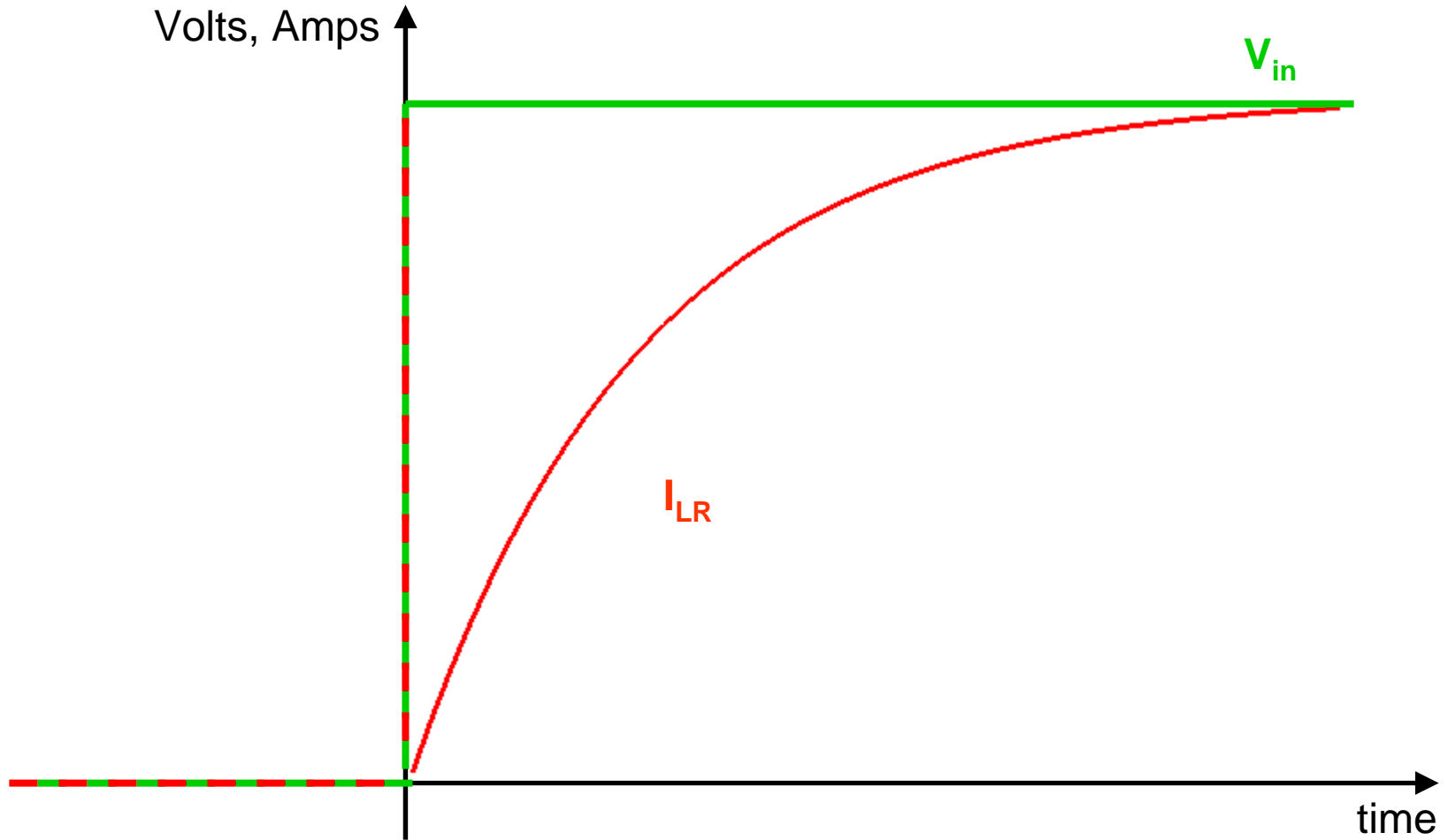
RC circuit: "AC" response



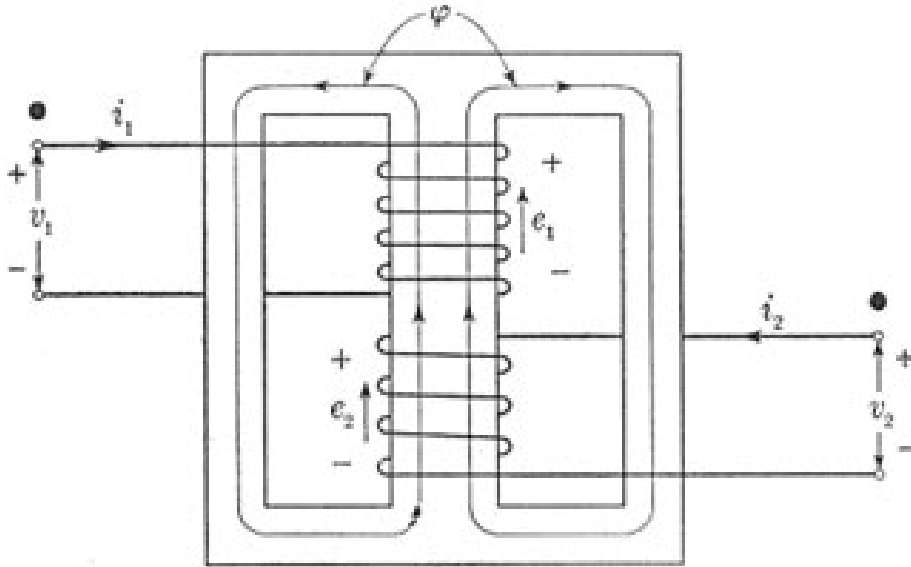
RC circuit: "AC" output performance



LR circuit: "DC" response



Transformers



[Diagram from www.obsoleteelectronics.com]

Conservation of Energy:

$$P_p = I_p V_p \geq P_s = I_s V_s$$

Transformers modify the impedance of an AC signal:

$$\frac{Z_p}{Z_s} = \left(\frac{N_p}{N_s} \right)^2$$

Transformer ratios obey the relation:

$$\frac{V_p}{V_s} = \frac{N_p}{N_s} = \frac{I_s}{I_p}$$



[image from www.ablecoil.com]