



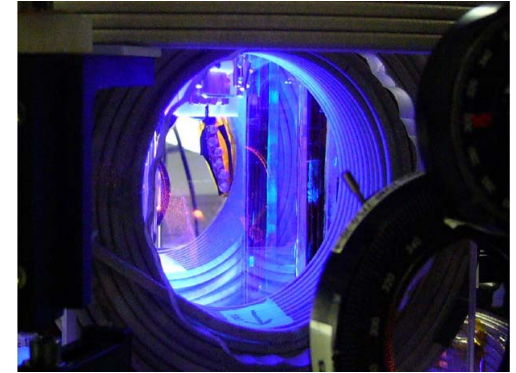
# Summer Research

- 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.

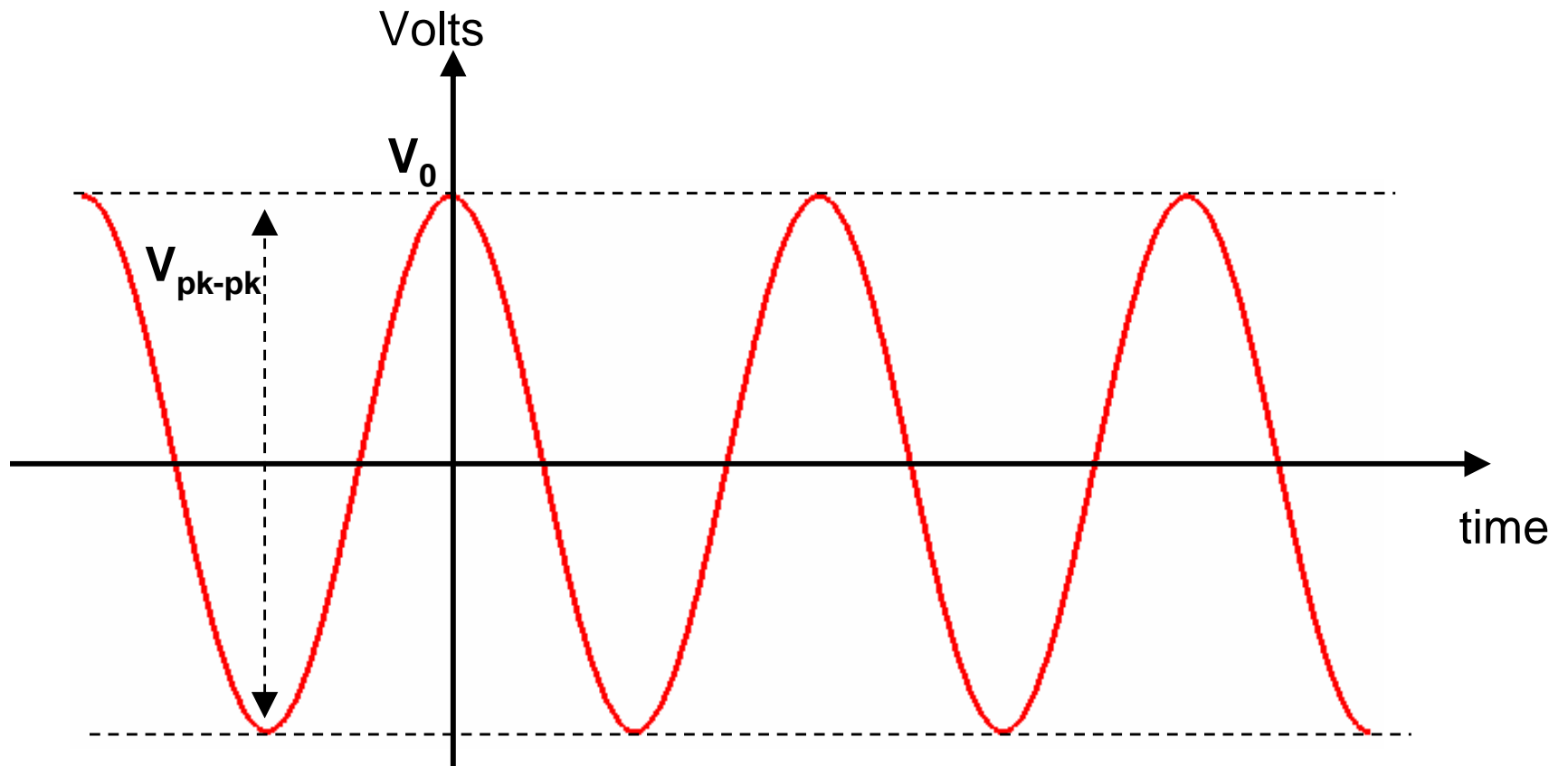
More info at: <http://www.wm.edu/scholarships/summeropps.php>



# 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:

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

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

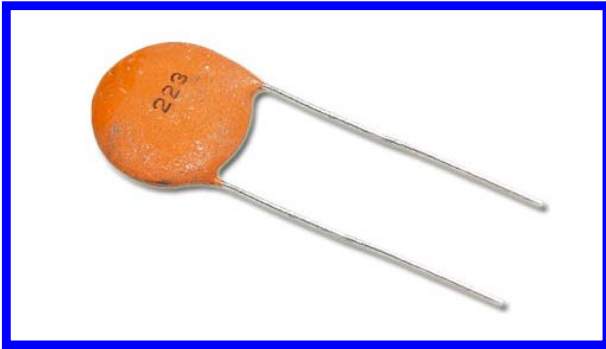
**Power:**  $P(t) = V(t) \cdot I(t)$

For a resistive AC circuit:

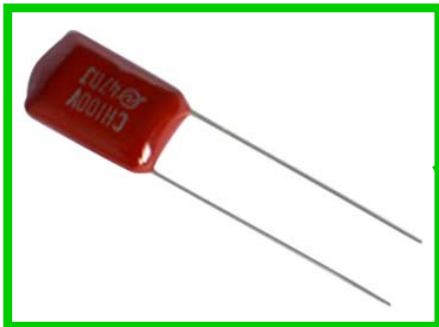
$$\langle P \rangle = I_{RMS} V_{RMS} = \frac{I_0 V_0}{2}$$



# Capacitors



[Image from www.tedss.com]



[Image from img.alibaba.com]



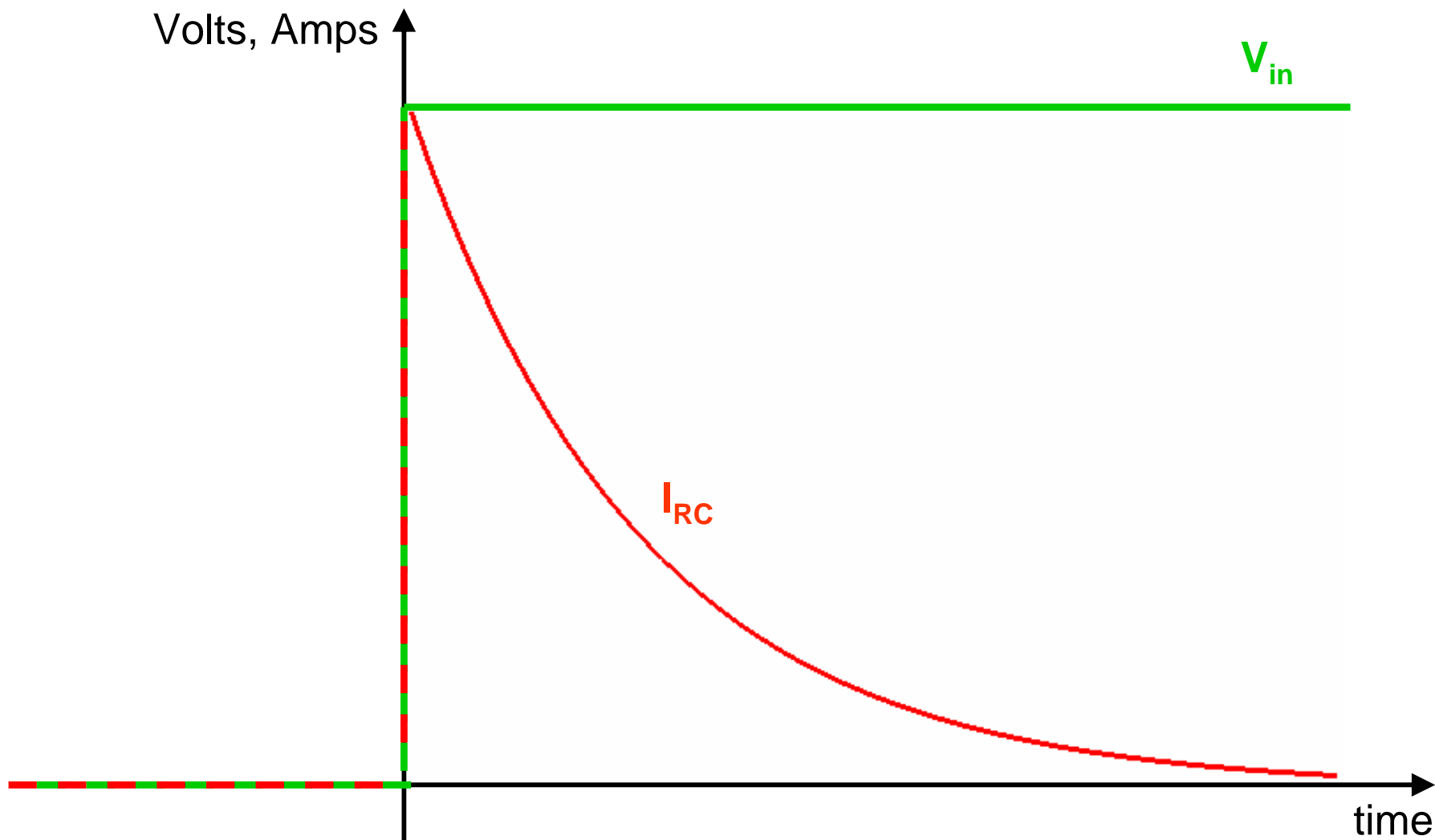
[Image from www.tedss.com]

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

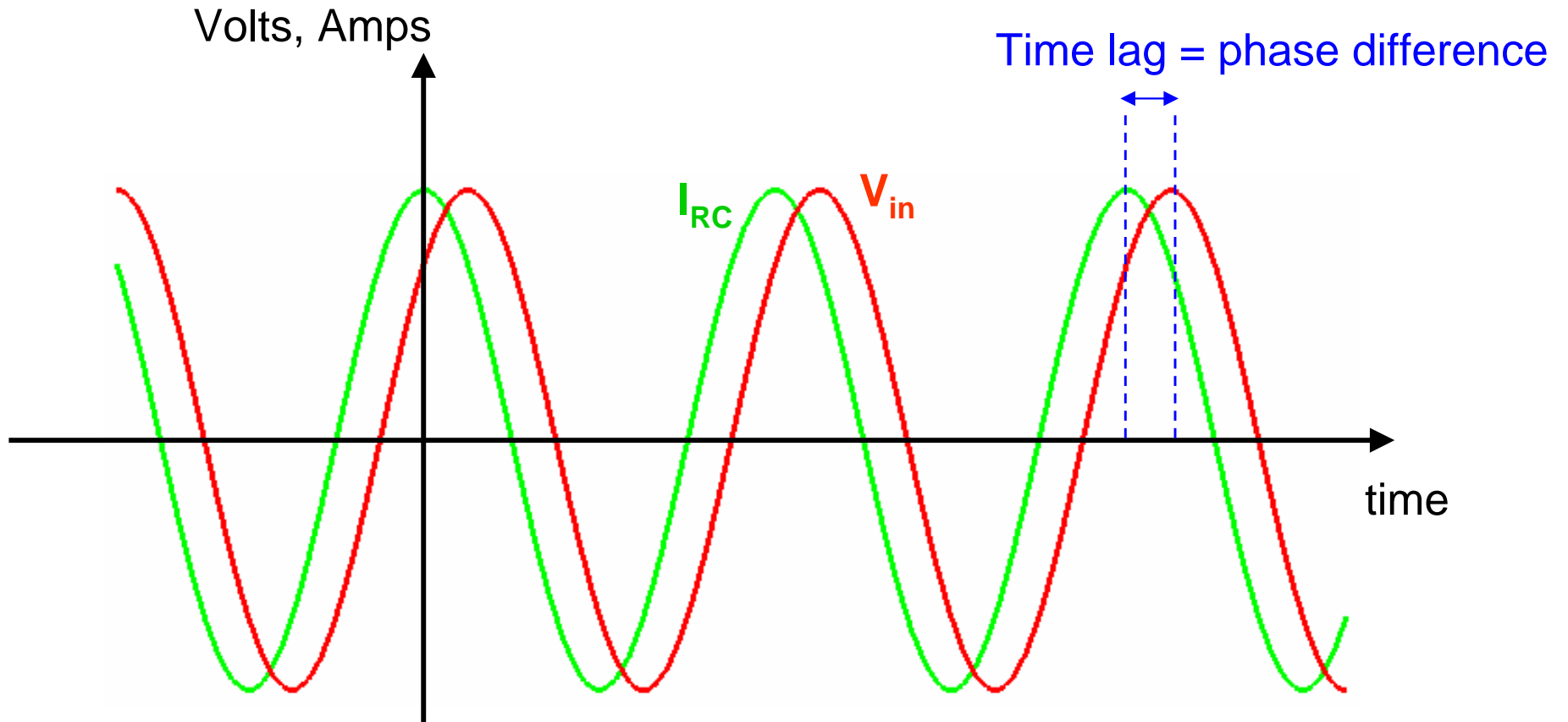


# RC circuit: "DC" response

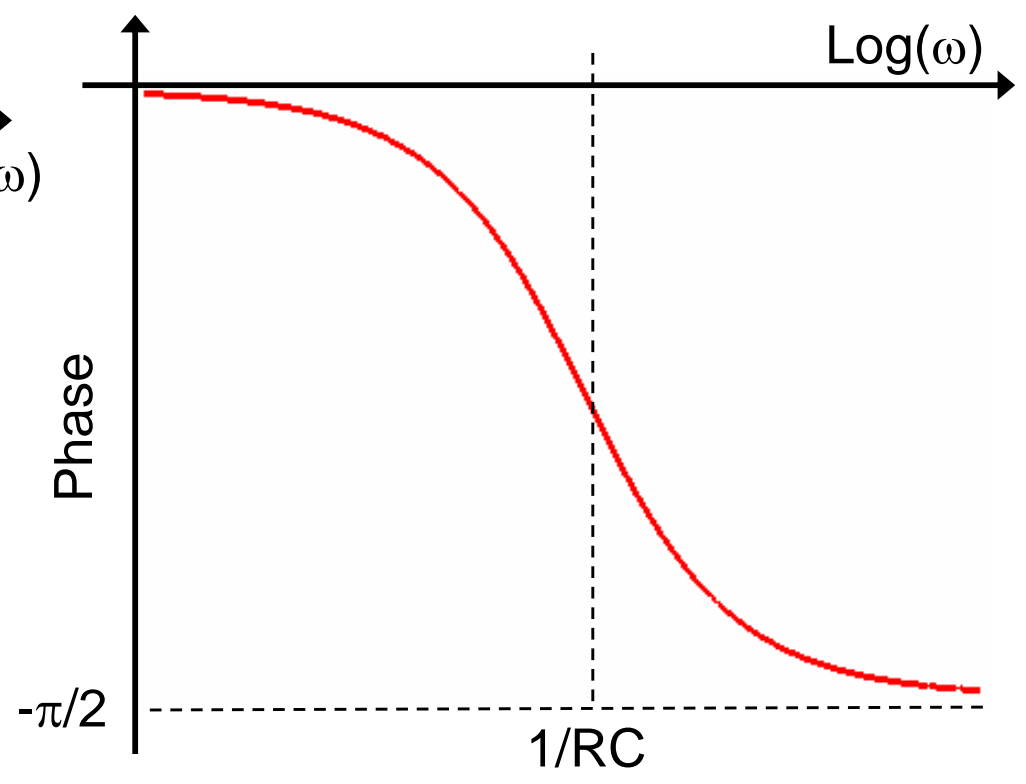
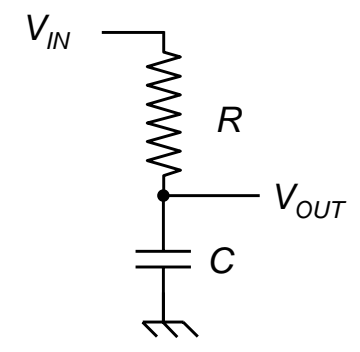
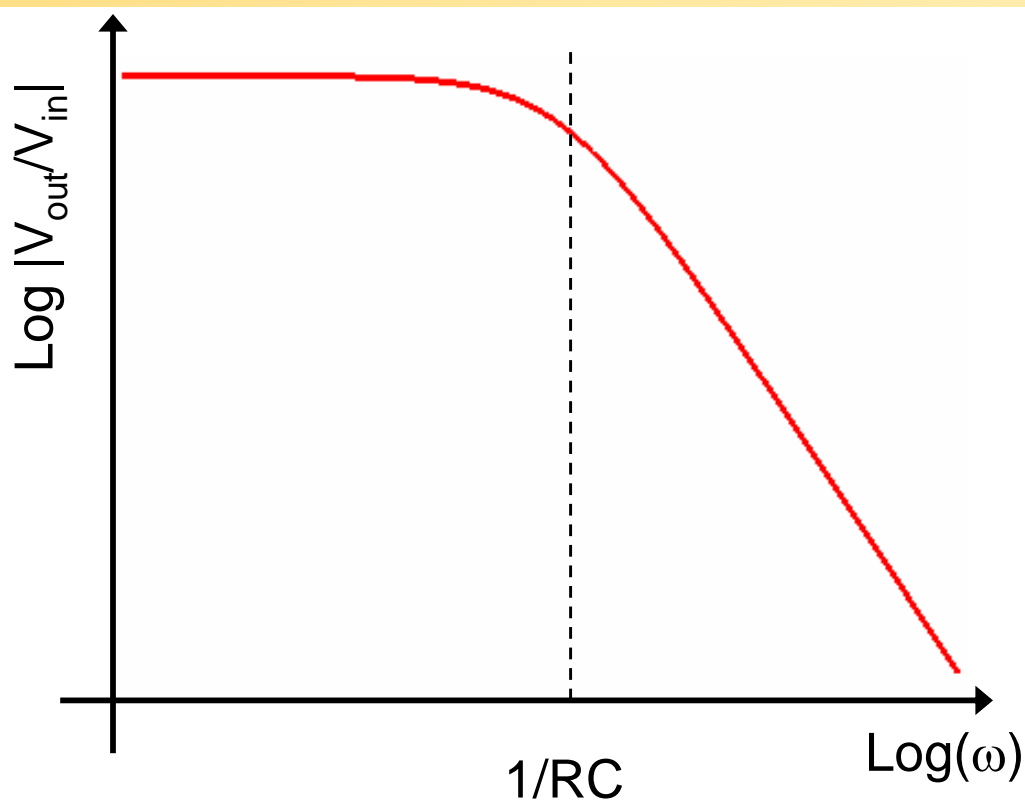




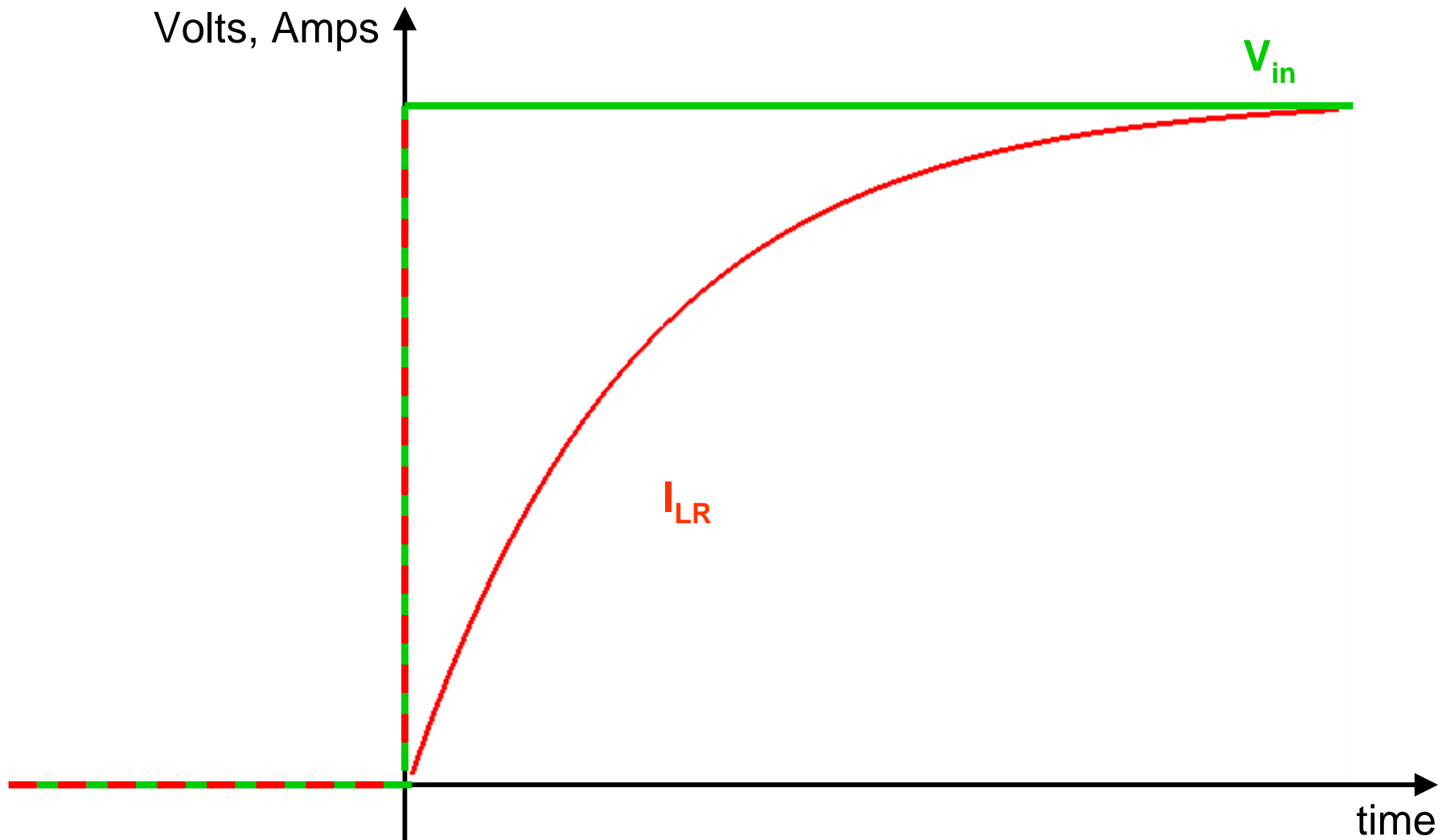
# RC circuit: "AC" response



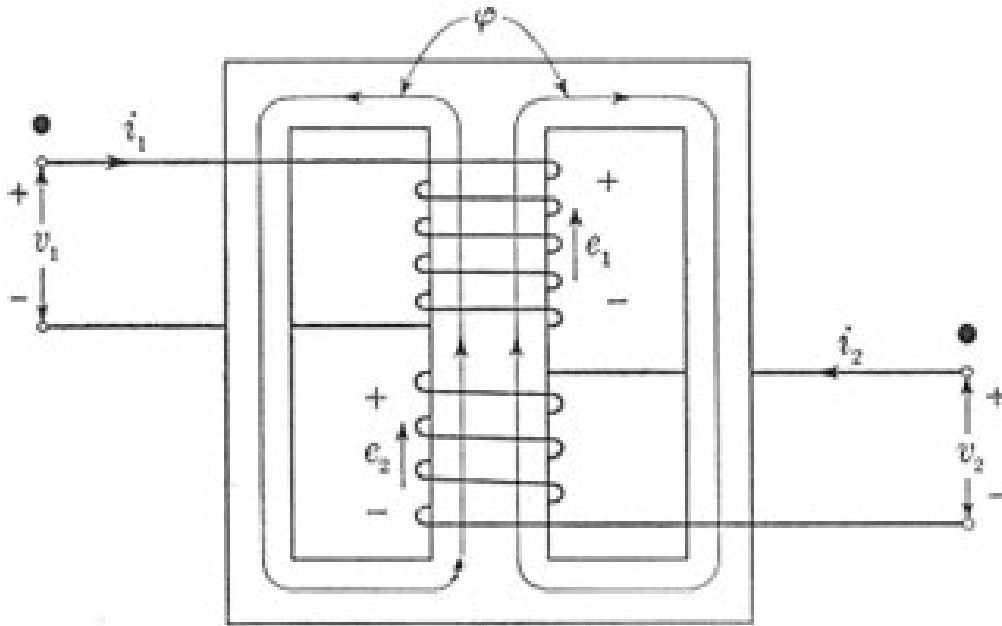
# RC circuit: "AC" output performance



# LR circuit: "DC" response



# Transformers



[Diagram from [www.obsoleteelectronics.com](http://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](http://www.ablecoil.com)]