Fundamentals of Electrical Engineering Voltages, Currents and Circuit Elements

- What are voltage and current?
- Circuit Elements



Voltage and Current

• Voltage (electric potential) provides the "push" for the flow of charged particles

+ – voltage has units of volts (v)

- Positive current is the flow of positively charged particles in the indicated direction

 i
 current has units of amperes (A)
- How charged particles flow in reaction to an applied voltage depends on the conducting medium



Circuit Elements

• A generic circuit element has a voltage *v* and a current *i* defined for it, with positive current flowing into the positive side of the voltage

Ideal wire
(short circuit) (open circuit)Dead wire
Resistor|ResistorCapacitor

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Inductor

v = 0 i = 0for all i for all v

R: Ohms (Ω) C: Farads (F) L: Henrys (H)

Resistors



 $10 \ \Omega \qquad 100 \ \Omega \qquad 1 \ k\Omega \qquad 10 \ k\Omega \qquad 100 \ k\Omega \ 1 \ M\Omega$

Resistors





Capacitors



470 μF 1 nF

Inductor



Circuit Elements



G: Siemens (S)









 $v(t) = v_s(t)$ for all i

 $i(t) = -i_s(t)$ for all v



Batteries



 $v(t) = v_s$ (constant) for "all" *i*



Current Sources?



 $i(t) = -i_s(t)$ for all v



Conservation of Energy

- The sum of the energies consumed/produced in a closed system is constant
- Power is the rate of change of energy

$$p(t) = \frac{dE}{dt}$$

• E = constant means p(t) = 0 at all times



Power

• The instantaneous power dissipated by a circuit element equals voltage times current

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

• Volts times amperes equals watts Resistor Capacitor





Linear Circuit Theory



