EIE/ENE 104
Electric Circuit Theory

Lecture 01a:
Circuit Analysis and Electrical Engineering

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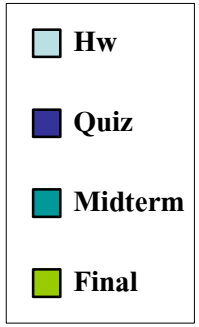
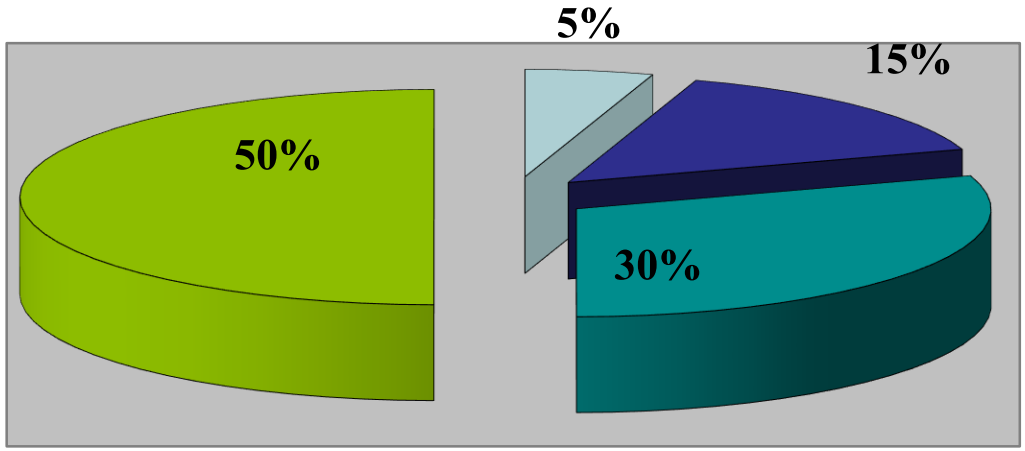
Evaluations:

- **Hw 5%**
- **Quiz 15%** (open book/no computer)
- **Midterm 30%** (closed book)
- **Final 50%** (closed book)

Note: absent from class > 2 => Fa



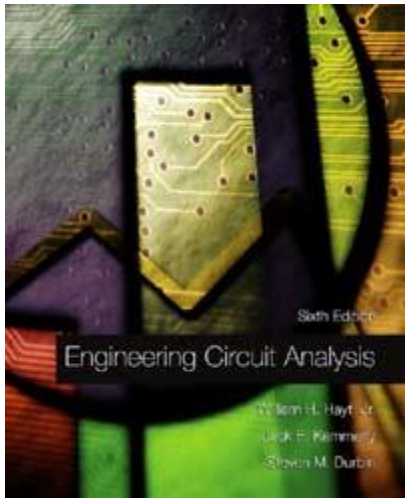


Course Description:

Electrical units and definitions: Voltage, current, power, energy, circuit elements: resistors, capacitors, inductors, independent and dependent sources, lumped circuits, Wye-Delta transformation. **Circuit Theory and analysis methods**: Kirchhoff's Laws, voltage and current divider, node and mesh analysis, Thevenin and Norton theorem, maximum power transfer, superposition theorem, two port circuits analysis. **Sinusoidal Steady State Analysis**: sinusoid properties, complex number representations, phasors, circuit theory and analysis method in AC circuits, power calculations, 3 phase AC circuits analysis.

Textbooks:

William H. Hayt, Jr., Jack E. Kemmerly, Steven M. Durbin "Engineering Circuit Analysis", Sixth edition, McGraw-Hill, 2002.

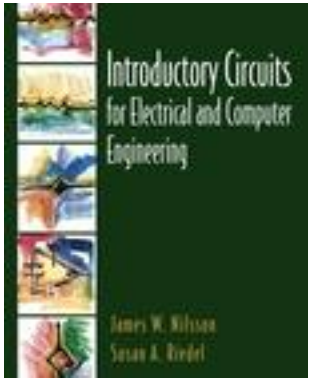


http://highered.mcgraw-hill.com/sites/0072283645/

Textbooks:

1. James W. Nilsson, Susan A. Riedel, "Electric Circuits" Seventh edition, Addison Wesley, 2005

2. James W. Nilsson, Susan A. Riedel, "Introductory Circuits for Electrical and Computer Engineering", First Edition, Prentice Hall,



URL:

http://www.prenhall.com/nilsson

Introduction:

An engineer must acquire many skills, one of which is knowledge of

electric circuit analysis.

Electrical Engineering:
Concerned with the systems that

- produce
- transmit
- measure

Electric signals

Introduction:

Five major classifications of electrical systems:

1. communication system
2. computer systems
3. control systems
4. power systems
5. signal-processing systems

=> Analyze and design

Introduction:

Circuit theory:

A field as diverse as electrical engineering

Electric circuits: common for EE. :

A **mathematical model**, which approximates the behavior of an actual electric system

Introduction:

Three basic assumptions permit us to use circuit theory: (rather than electromagnetic field theory)

1. Electric effects happen instantaneously through out a system: electric signals travel at or near the speed of light. A system which is small enough so that we can make this assumption is called “a lumped-parameter system”
2. The net charge on every component in the system is always zero.
3. There is no magnetic coupling between the components in a system.

Overview:

Linear circuit analysis:

- **Resistive circuit analysis**: introduce a number of very powerful techniques, such as nodal analysis, mesh analysis, superposition, etc.
- **time-domain analysis**: allow capacitors and inductors to be included in a circuit.
- **frequency-domain analysis**: transform differential equations into more easily managed algebraic equations.

Relationship:

Relationship of Circuit Analysis to Engineering:

Learning how to analyze a problem.
To learn how to

- To be methodical
- To determine the goal of a particular problem
- To work with the information given to develop a plan of attack
- To implement the plan to obtain a solution
- To verify that the proposed solution is accurate

Analysis and Design:

This text is focused on developing our ability to analyze and solve problem.

Developing our design skills comes less naturally to us than developing our analytical skills.

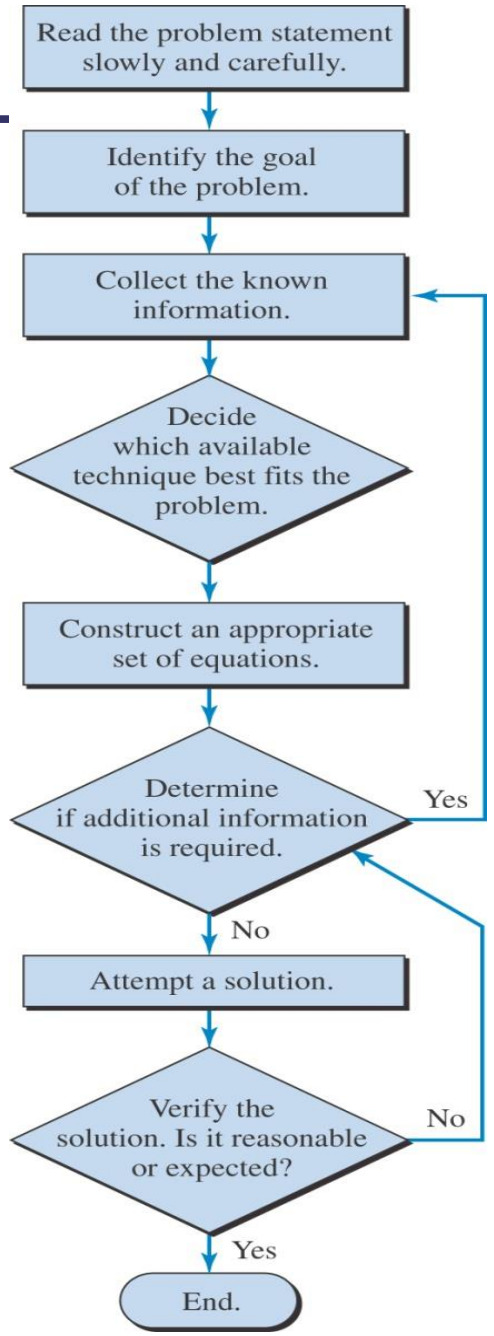
Computer-Aided Analysis:

Modern circuit analysis software is rapidly increasing in its level of integration.

We need to have a solid understanding of how circuits work in order to develop an ability to design them.

Problem-Solving:

A suggested problem-solving flow chart



Problem-Solving:

Develop the skills to successfully attack the unsolved problems

1. Identify what's given and what's to be found
2. Sketch a circuit diagram or other visual model
   - label, reference, redraw to simple form
   - simplified
3. Think of several solution methods and a way of choosing among them
4. Calculate a solution
   - paper and pencil
   - calculator
5. Use your creativity
6. Test your solution

ENE 104
Electric Circuit Theory

Lecture 01b:
Basic Components and Electric Circuits

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Objectives:

- Definition of **basic electrical quantities** and associated units
- The relationship between **charge**, **current**, **voltage**, and **power**
- The passive sign **convention**
- Dependent and independent voltage and current **sources**
- The behavior of the resistor and **Ohm's law**

Units and Scales:

TABLE **2.1** SI Base Units

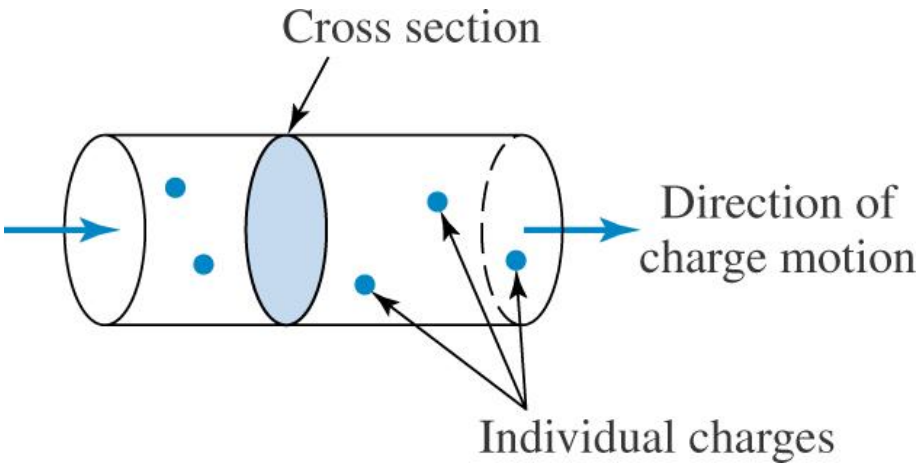
Base Quantity	Name	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

Units and Scales:

TABLE **2.2** SI Prefixes

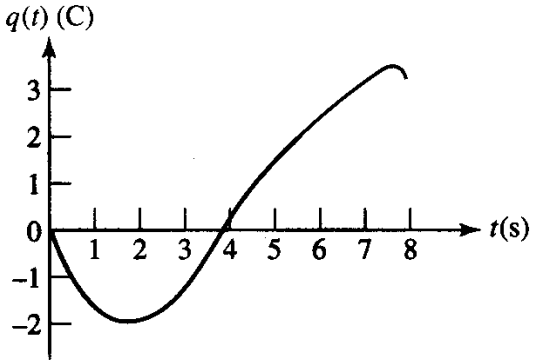
Factor	Name	Symbol	Factor	Name	Symbol
10^{-24}	yocto	y	10^{24}	yotta	Y
10^{-21}	zepto	z	10^{21}	zetta	Z
10^{-18}	atto	a	10^{18}	exa	E
10^{-15}	femto	f	10^{15}	peta	P
10^{-12}	pico	p	10^{12}	tera	T
10^{-9}	nano	n	10^{9}	giga	G
10^{-6}	micro	μ	10^{6}	mega	M
10^{-3}	milli	m	10^{3}	kilo	k
10^{-2}	centi	c	10^{2}	hecto	h
10^{-1}	deci	d	10^{1}	deka	da

Charge:



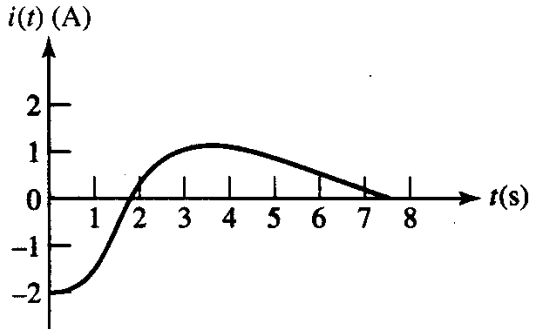
$$i = \frac{dq}{dt}$$

Figure 2.2



A graph of the instantaneous value of the total charge $q(t)$ that has passed a given reference point since $t = 0$.

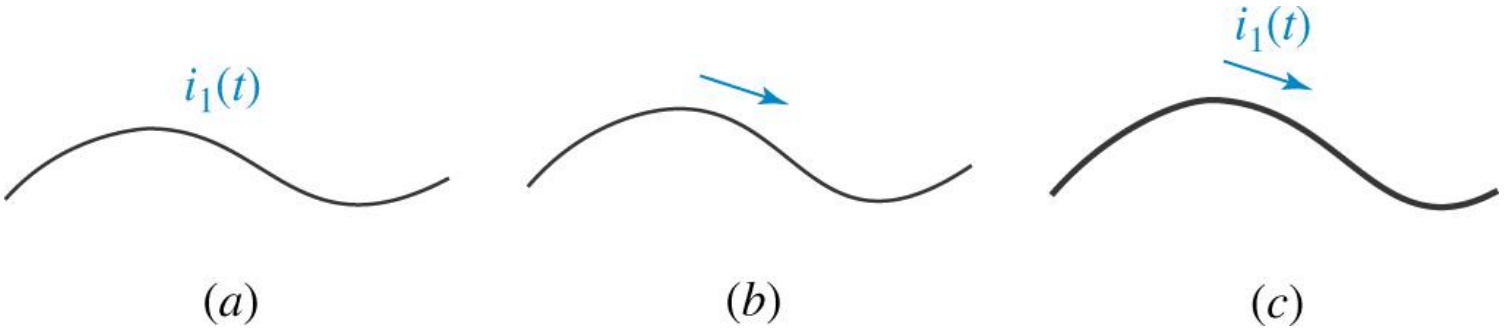
Figure 2.3



The instantaneous current $i = dq/dt$, where q is given in Fig. 2.2.

Current:

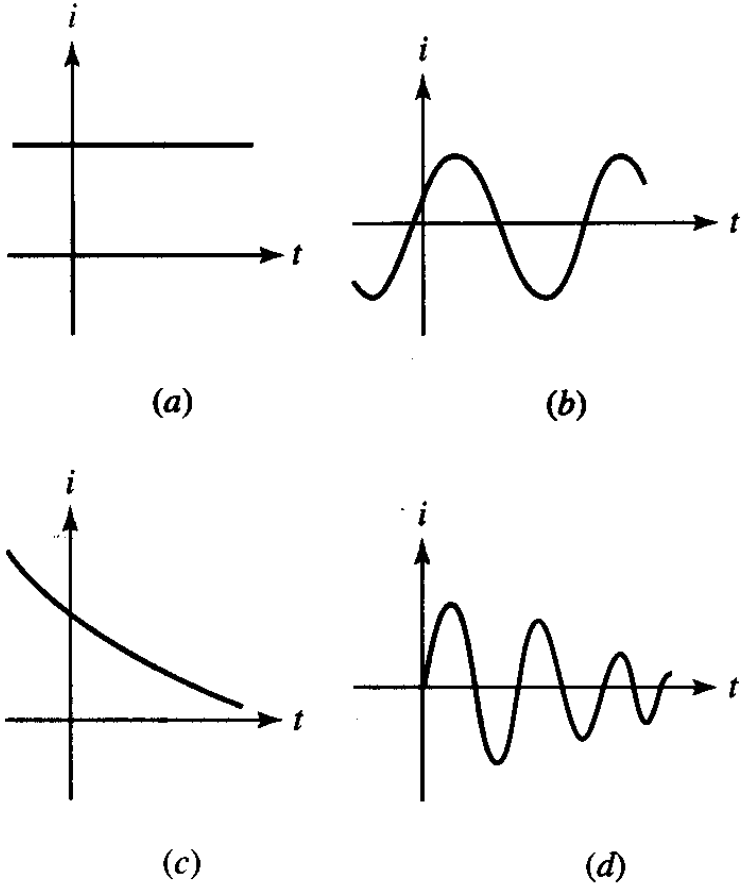
Two different methods of labeling the same current.



(a, b) Incomplete, improper, and incorrect definitions of a current.
(c) the correct definition of $i_1(t)$.

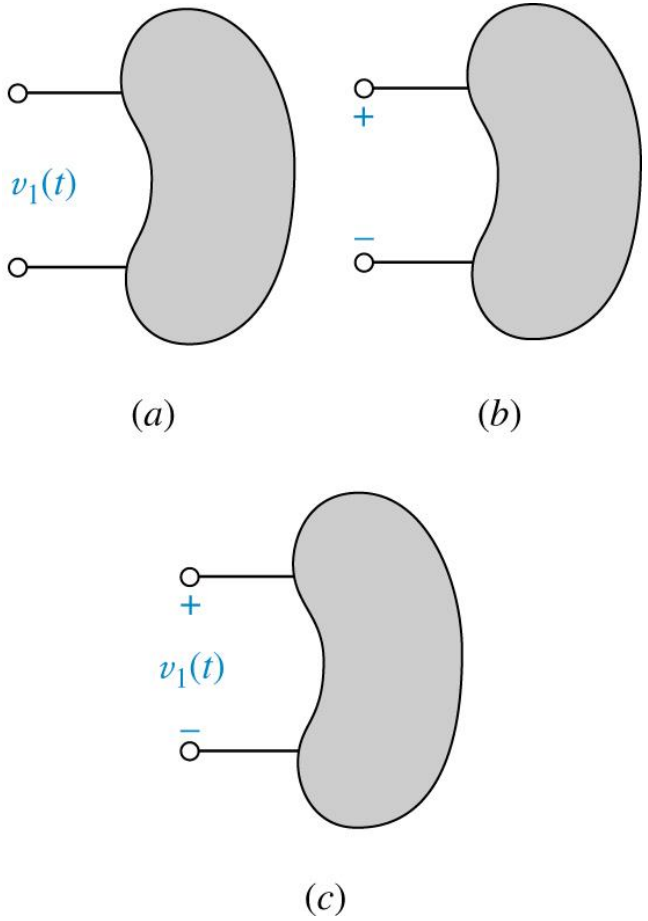
Current:

Figure 2.4

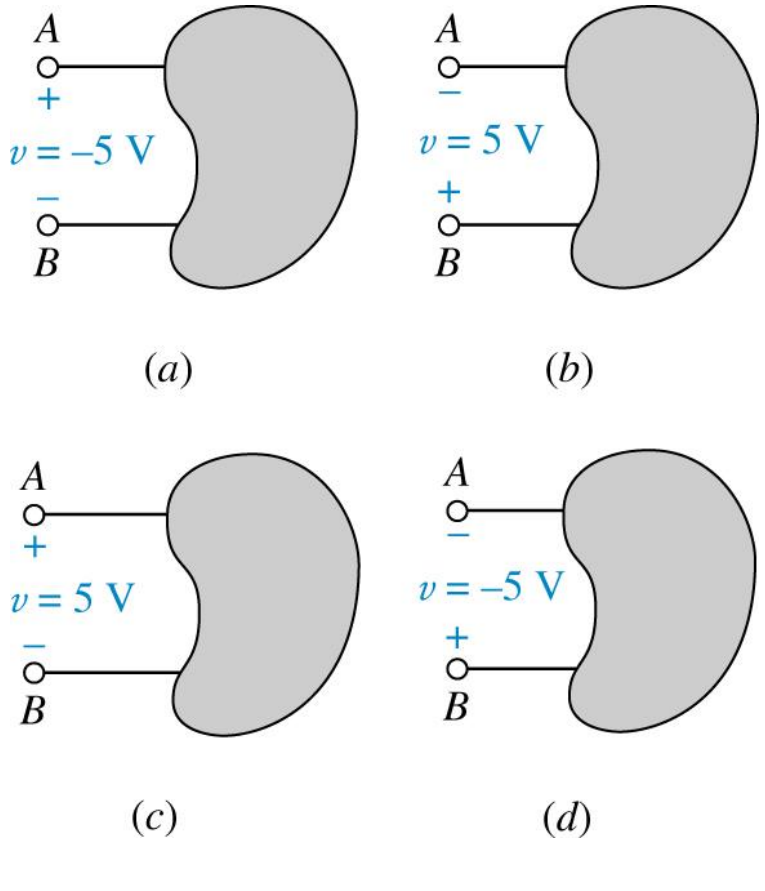


Several types of current: (*a*) Direct current (dc). (*b*) Sinusoidal current (ac). (*c*) Exponential current. (*d*) Damped sinusoidal current.

Voltage:

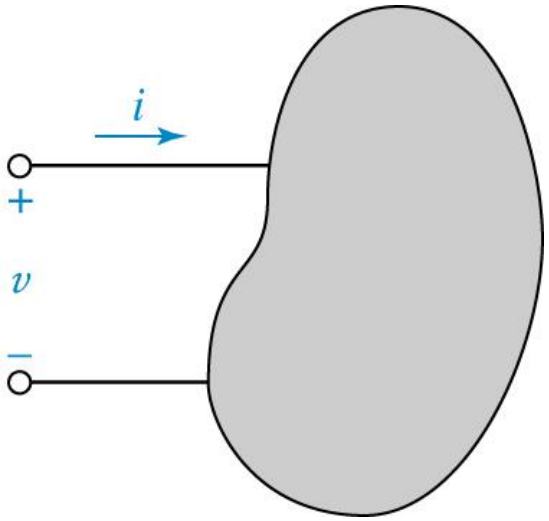


(a, b) These are inadequate definitions of a voltage. (c) A correct definition includes both a symbol for the variable and a plus-minus symbol pair.



(a, b) Terminal B is 5 V positive with respect to terminal A; (c, d) terminal A is 5 V positive with respect to terminal B.

Power:

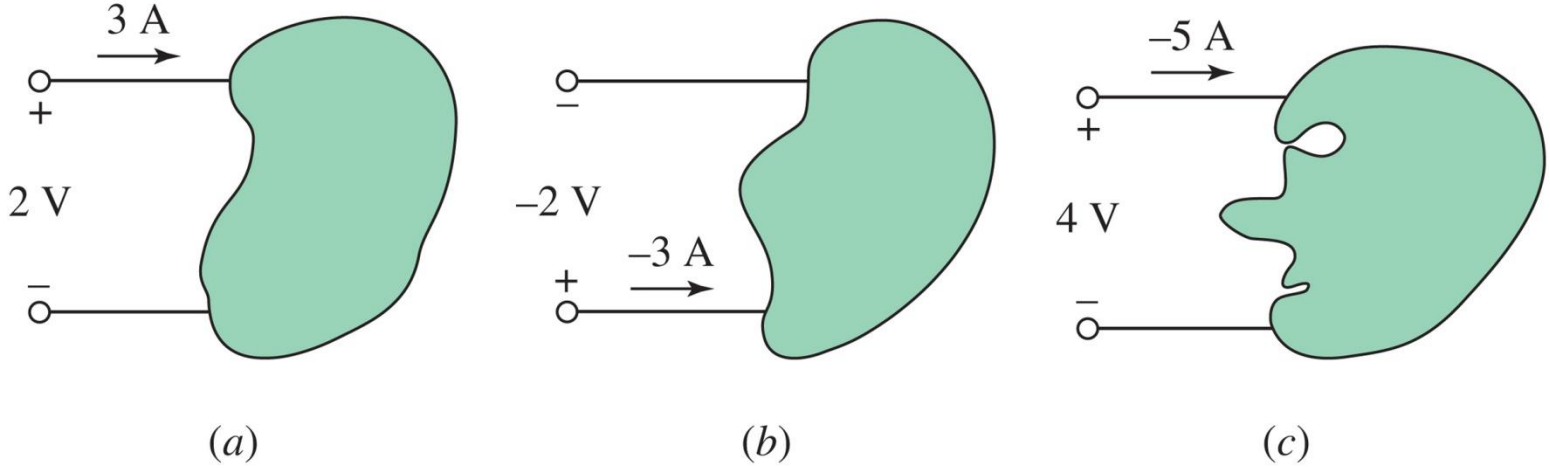


The power absorbed by the element is given by the product $p = vi$.
Alternatively, we can say that the element generates or supplies a power $-vi$.

If the current arrow is directed **into** the " +" marked terminal of an element, then *p* = *vi* yields the **absorbed** power. A negative value indicates that power is actually being generated by the element.

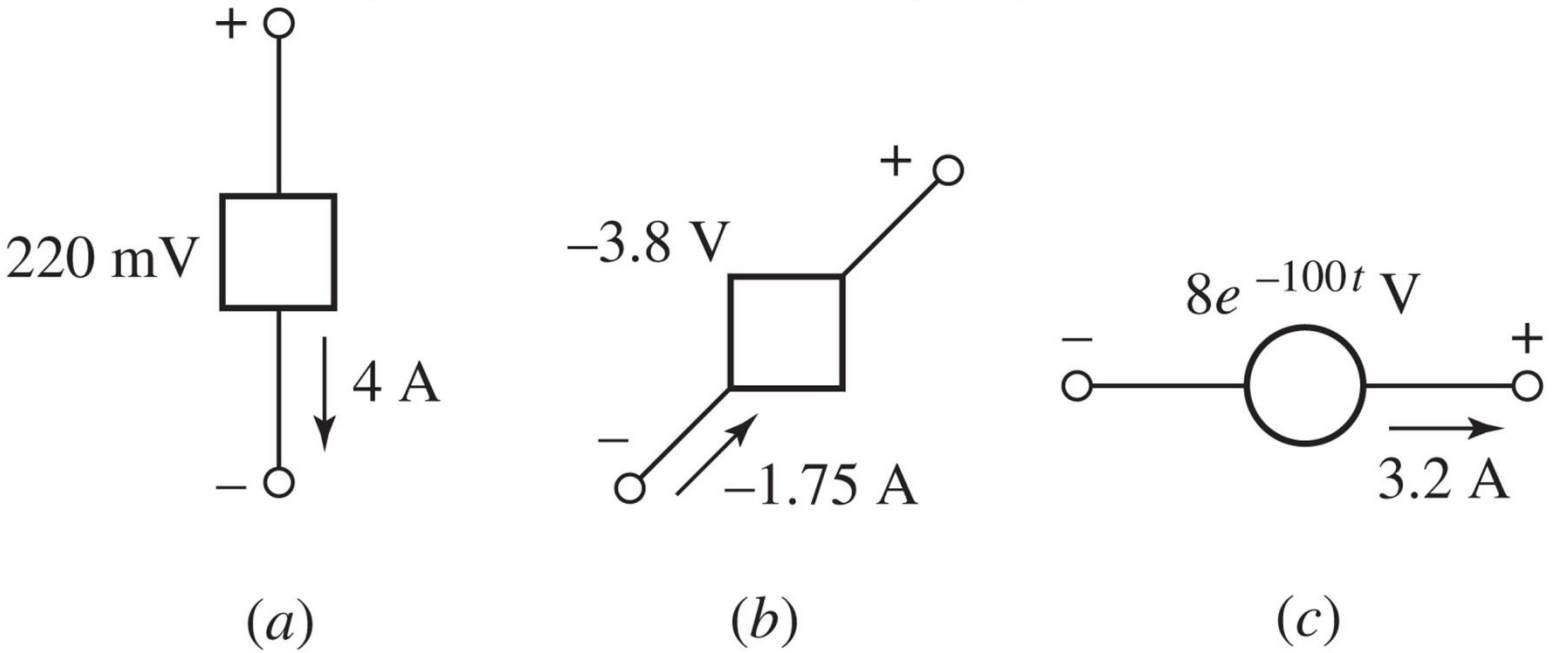
If the current arrow is directed **out of** the " +" terminal of an element, then *p* = *vi* yields the **supplied** power. A negative value in this case indicates that power is actually being absorbed instead of generated.

Power:



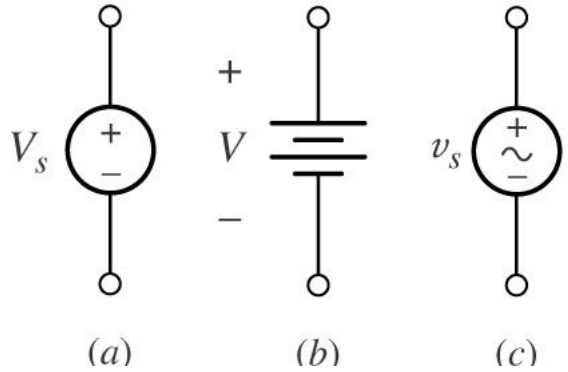
Compute the power absorbed by each part.

Power:

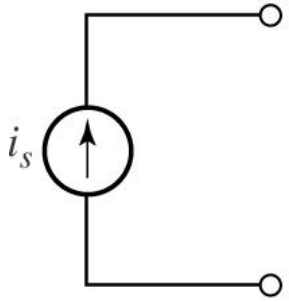


Compute the power absorbed by each part.

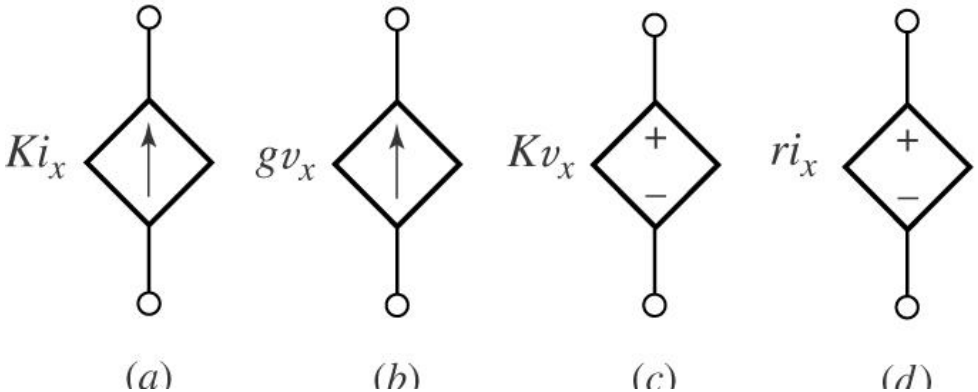
Sources:



Symbol for: (a) DC voltage source; (b) battery; (c) ac voltage source.



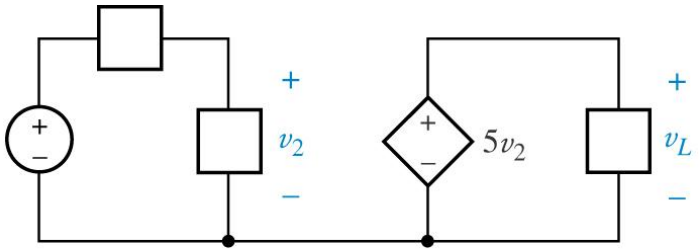
Symbol for an independent current source.



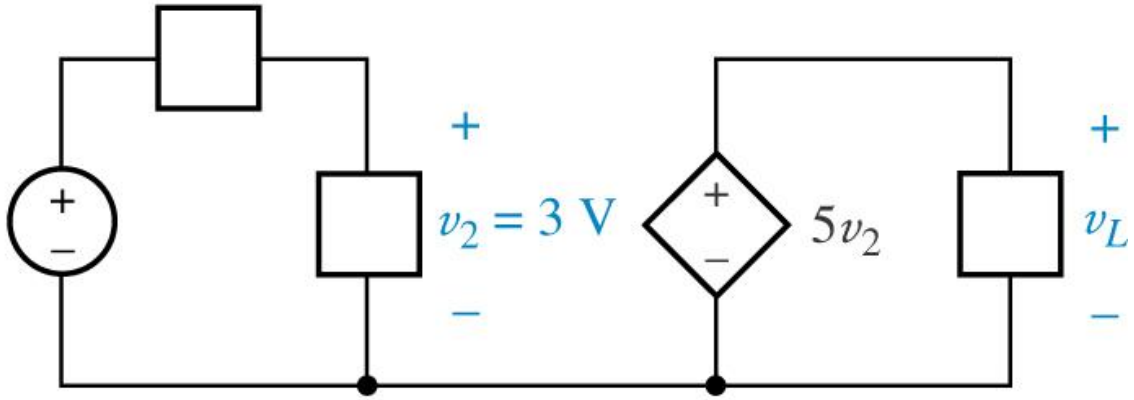
The four different types of dependent sources: (a) current-controlled current source; (b) voltage-controlled current source; (c) voltage-controlled voltage source; (d) current-controlled voltage source.

Example:

In the circuit below ,if v_2 is known to be 3 V, find v_L .



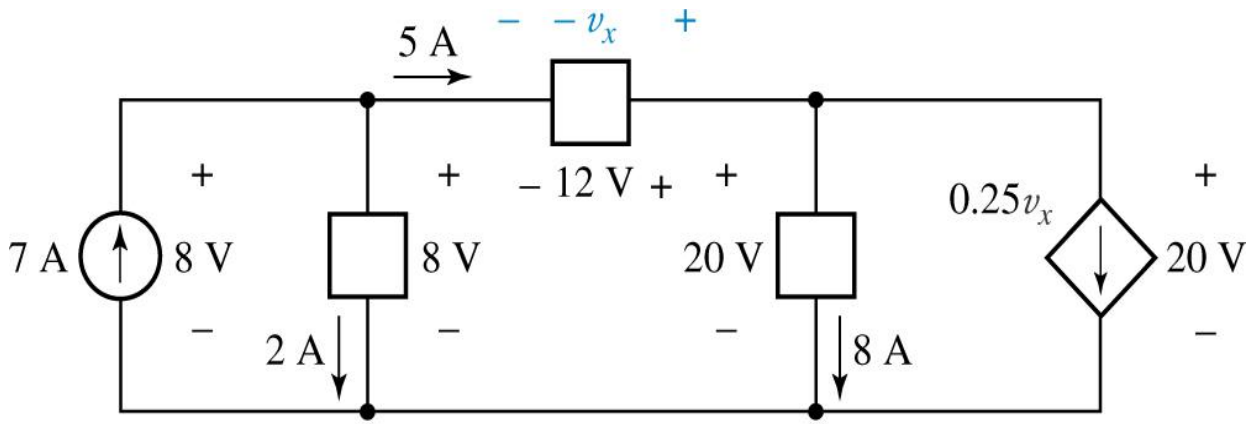
(a)



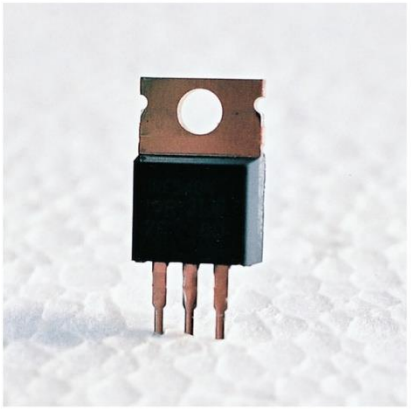
(b)

Example:

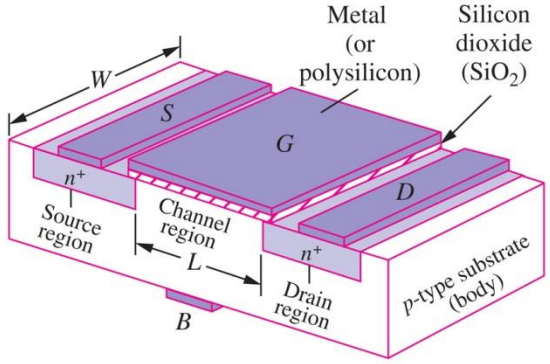
Find the power absorbed by each element in the circuit below.



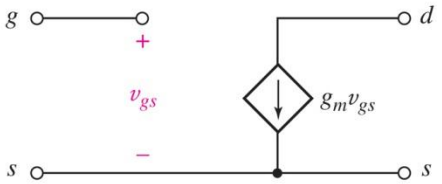
The MOSFET:



(a)



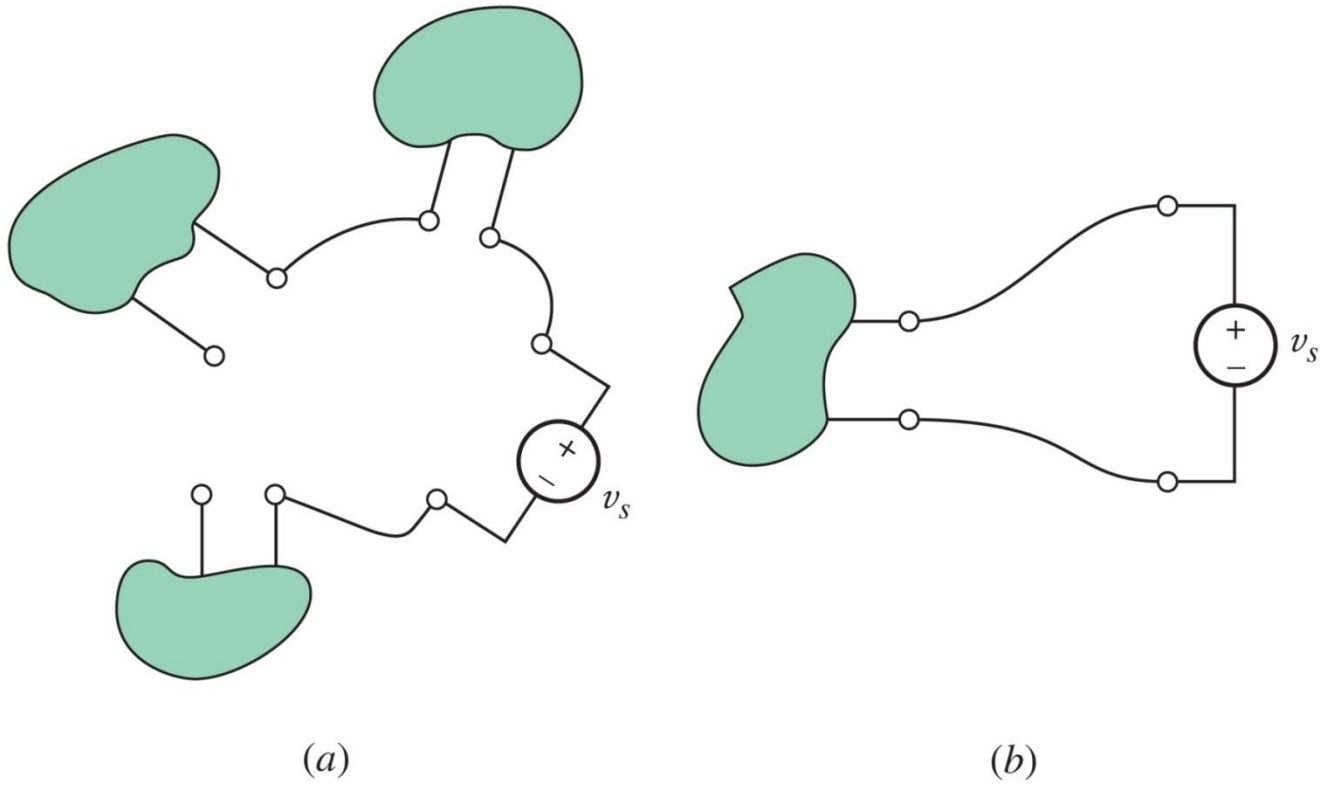
(b)



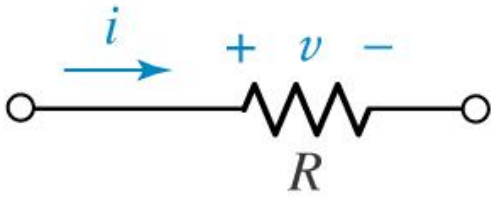
(c)

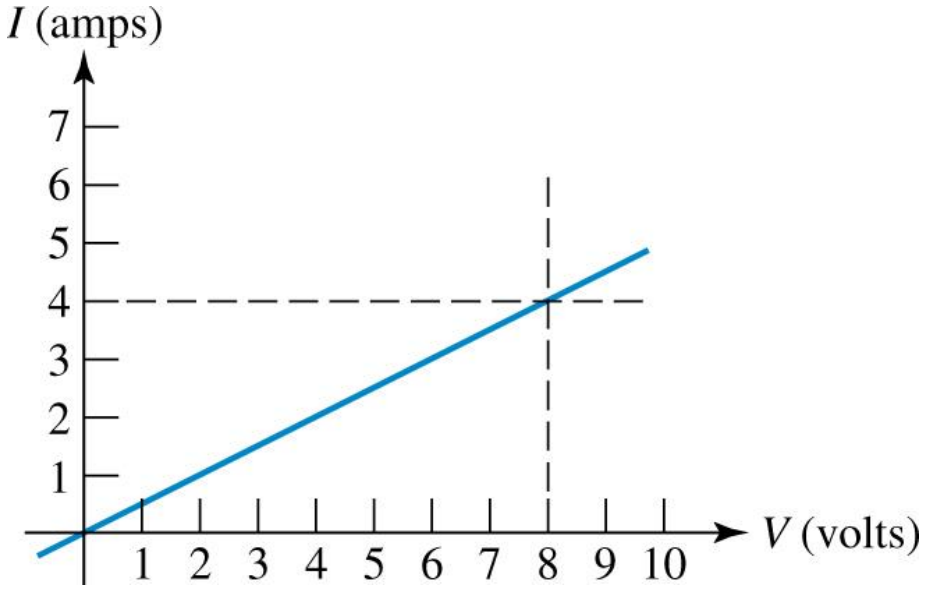
Network and Circuits:

The interconnection of two or more simple circuit elements forms and electrical **network**. If the network contains at least one closed path, it is also an electric **circuit**.



Ohm's Law:





$$v = i\,R$$

or

$$i = \frac{v}{R}$$

Ohm's Law:

passive element: R, L, C
active element: sources

Power absorbtion:

$$p = vi = i^2 R = \frac{v^2}{R}$$

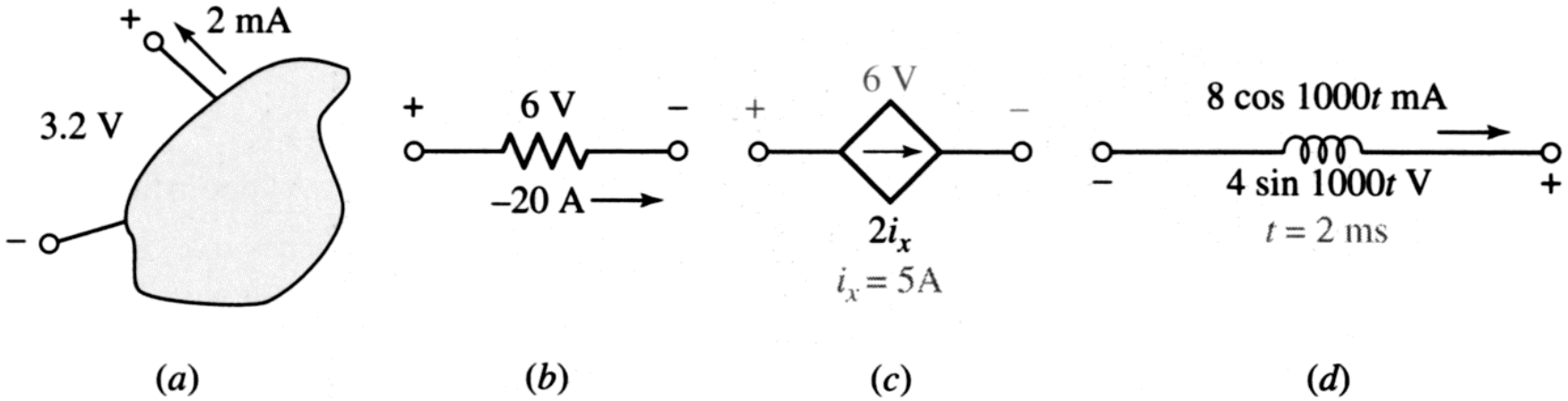
Conductance

$$G = \frac{1}{R} = \frac{i}{v} \text{ siemens(S) , or mho}$$

$$p = vi = v^2 G = \frac{i^2}{G}$$

Example:

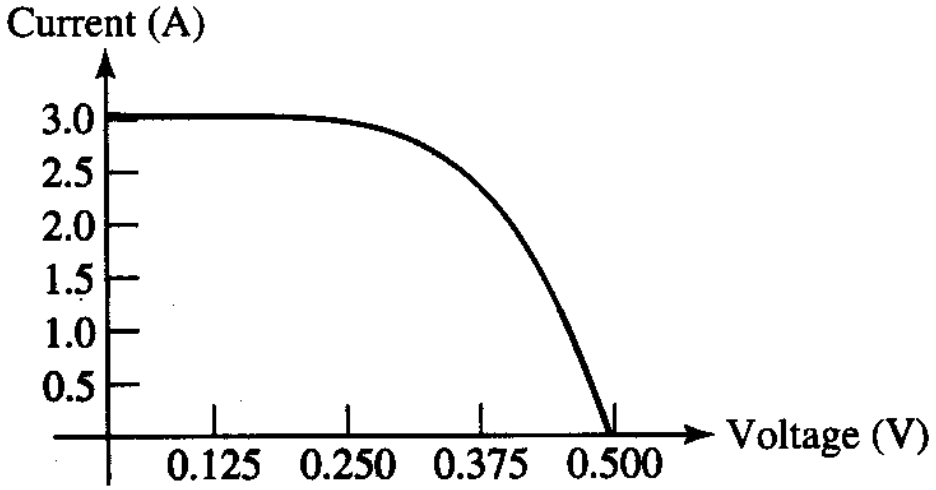
Determine the power being absorbed by each of the circuit elements shown



Example:

13. The current-voltage characteristic of a silicon solar cell exposed to direct sunlight at twelve noon in Florida during midsummer is given in Fig. 2.31. It is obtained by placing different size resistors across the two terminals of the device, and measuring the resulting currents and voltages.

Figure 2.31



(*a*) What is the value of the short-circuit current?
(*b*) What is the value of the voltage at open circuit?
(*c*) Estimate the maximum power that can be obtained from the device.

Homework:

Reference:

W.H. Hayt, Jr., J.E. Kemmerly, S.M. Durbin, Engineering Circuit Analysis, Sixth Edition.