BLM2534 ELEKTRONİK

Syllabus

Week	Subjects	Week	Subjects
1	Basic Circuit Elements, Resistors, Ohm's Law	8	Diodes
2	Kirchhoff's Law (Voltage and Current)	9	Bipolar Junction Transistor (BJT)
3	Node Voltage Method	10	Bipolar Junction Transistor (BJT)
4	Mesh Current Method	11	BJT biasing
5	Thevenin and Norton Equivalents	12	BJT amplifiers
6	Thevenin and Norton Equivalents	13	Operational amplifiers
7	Superposition	14	Operational amplifiers

GRADING

Midterm Exam	15 %
Lab Performance + Quiz + Homeworks + etc	15 %
Final Exam	80 %

1) ANY ABSENCIES FROM A LAB SESSION WITHOUT ANY OFFICIAL EXCUSE WILL BRING 0 GRADE FROM that lab. This rule will strictly be applied throughout the course.
2) Pre lab /Pre tutorial preparation is a must .

Book: ELECTRIC CIRCUITS (James W. Nilsson & Susan A. Riedel, **Prentice Hall**)
Lecture Notes (Slides)

The International System of Units(SI)

Quantity	Basic Unit	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Electric Current	Ampere	A
Thermodynamic temperature	Degree kelvin	K
Amount of substance	Mole	Mol
Luminous intensity	Candela	cd

The SI units are based on these 7 defined quantities

Derived Units in SI

Quantity	Name	Symbol	Expression
Frequency	Hertz	Hz	$1/s$
Force	Newton	N	$kg \cdot m/s^2$
Pressure, stress	Pascal	Pa	$N/m^2 = kg/m \cdot s^2$
Energy, work	Joule	J	$N \cdot m = kg \cdot m^2/s^2$
Power, radiant flux	Watt	W	$J/s = kg \cdot m^2/s^3$
Electric charge	Coulomb	C	$A \cdot s$
Voltage, electric potential	Volt	V	$W/A = kg \cdot m^2/A \cdot s^3$
Capacitance	Farad	F	$C/V = s^4A^2/m^2kg$
Electric resistance	Ohm	Ω	$V/A = m^2kg/s^3A^2$
Conductance	Siemens or mho	S or Ω	$1/\Omega = s^3A^2/m^2kg$
Magnetic field	Tesla	T	$N/A \cdot m = kg/s^2A$
Magnetic flux	Weber	Wb	$T \cdot m^2 = m^2kg/s^2A$
Inductance	Henry	H	$V \cdot s/A = m^2kg/s^2A^2$

Standardized Prefixes to Signify Powers of 10

atto	a	10^{-18}
femto	f	10^{-15}
pico	p	10^{-12}
nano	n	10^{-9}
micro	μ	10^{-6}
milli	m	10^{-3}
centi	c	10^{-2}
deci	d	10^{-1}
deka	da	10
hecto	h	10^{2}
kilo	k	10^{3}
mega	M	10^{6}
giga	G	10^{9}
tera	T	10^{12}

SI units Example

Example 1.1 Using SI Units and Prefixes for Powers of 10

If a signal can travel in a cable at 80% of the speed of light, what length of cable, in cm represents 1 ns?

Solution

First, note that 1 ns=10^{-9} s. Also recall that the speed of light c= 3 x 10^8 m/s. Then, 80% of the speed of light is 0.8c = (0.8)(3 x 10^8) = 2.4 x 10^8 m/s. Using a product of ratio, we can convert 80% of the speed of light from meters-per-second to cm-per-nanosecond. The result is the distance in cm traveled in 1 ns:

$$\frac{2.4 \times 10^8\, meters}{1\, second} \cdot \frac{1\, second}{10^9\, nanoseconds} \cdot \frac{100\, centimeters}{1\, meters}$$

$$\frac{(2.4 \times 10^8)(100)}{10^9} = 24\, cm/nanoseconds$$

Therefore, a signal traveling at 80% of the speed of light will cover 24 cm of cable in 1 nanosecond.

Circuit Analysis

- **Ideal Circuit:** The elements that comprise the circuit model are called **ideal circuit components.** An ideal circuit component is a mathematical model of an actual electrical component, like a battery or a light bulb.

- **Actual Circuit (physical prototype):** The **physical prototype** is an actual electrical system, constructed from actual electrical components. Measurement techniques are used to determine the actual, quantitative behavior of the physical system.

Current Voltage and Power

Electric Charge:

- The concept of electric charge is the physical basis for describing electrical phenomena.
- Charge is represented by the symbol q. It is measured in coulombs (C).
- Charge is either positive or negative.
- The charge of an electron is $q_e = 1.602 \times 10^{-19}$ C.

Charge is not easy to measure directly. In engineering the related signal variable **current** is used instead.

Current

- The symbol used for Current is i or $i(t)$
- Current is a measure of the **flow of electric charge over** time. It is defined as **$i=dq/dt$**
- The units of current are amperes (A).
- 1 A = 1C/s (1 Ampere = 1 coulomb/second).

  Since $1/(1.602\times10^{-19})=6.24\times10^{18}$, 1A corresponds to the flow of 6.24×10^{18} electrons per second.

Current

- Since charge can be positive or negative, Current can be ***positive or negative***.
- By convention, the ***direction of current*** is the direction of the net flow of positive charge. This is called conventional current.
- The flow of negative charge (electrons) in the opposite direction is called ***electronic current***.

Energy

- Moving charge from a point A to a point B in a circuit requires energy.
- Energy is represented by the symbol w. It is measured in *joules (J)*.

Voltage

- Measuring energy is not convenient.
- In engineering the related signal variable ***voltage***, denoted by v, is used.
- The voltage between two points A and B is defined as ***v=dw/dq***, i.e., it is the change in energy per unit charge as charge passes through a circuit from point A to point B.
- The units of voltage are ***volts (V)***. 1V=1J/C

Power

Power p, measured in watts (W), is the time rate of change of energy: p=dw/dt,

$$p = \frac{dw}{dt}$$

where

p = power in Watts,

w = the energy in joules,

t = the time in seconds

Thus 1 W = 1 J/s

The power associated with the flow of charge follows directly from the definition of voltage and Current

$$p = \frac{dw}{dt} = \left(\frac{dw}{dq}\right)\left(\frac{dq}{dt}\right)$$

p=v.i

Where

p = power in Watts,

v = the voltage in volts,

i = the Current in amperes

CIRCUIT ELEMENTS

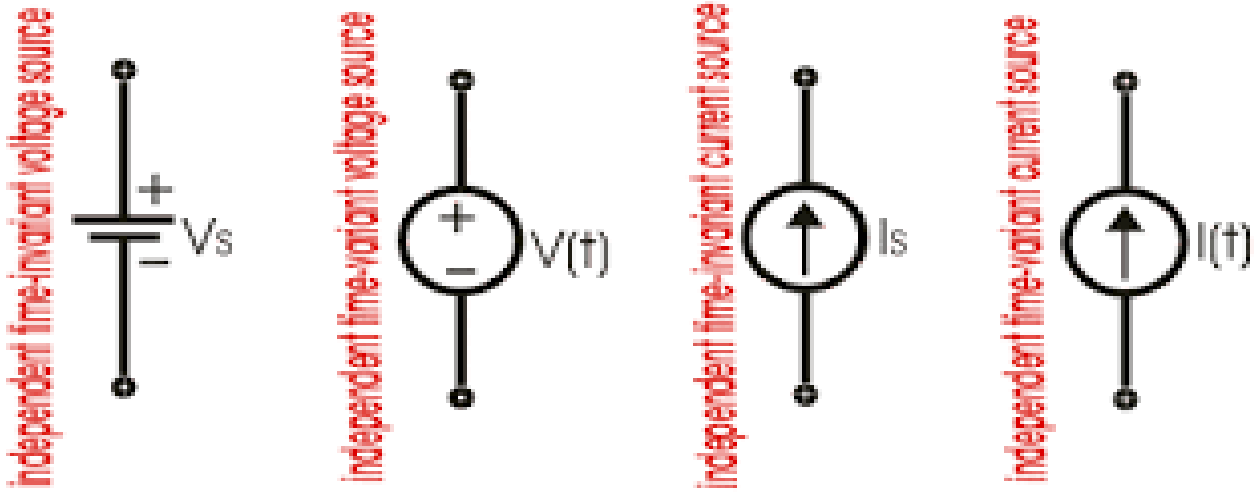
- There are five ideal basic circuit elements:
  - Voltage Sources
  - Current Sources,
  - Resistors
  - Inductors,
  - Capacitors

For now we will start with Voltage Sources, Current Sources and Resistors.

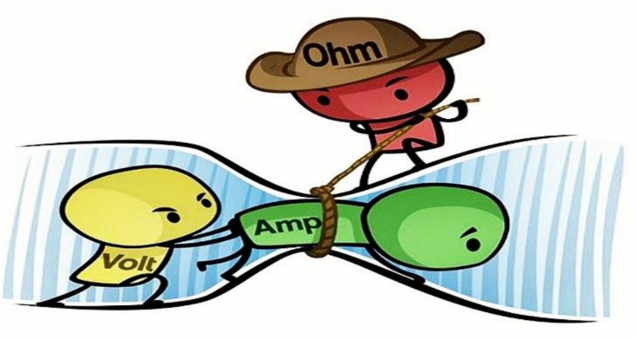
Voltage and Current Sources

- An **electrical source** is a device that is capable of converting nonelectric energy to electric energy and vice versa.

- An **ideal voltage source** is a circuit element that maintains a prescribed voltage across its terminals regardless of the current flowing in those terminals.
- An **ideal current source** is a circuit element that maintains a prescribed current through its terminals regardless of the voltage across those terminals.



Electrical Resistance (Ohm's Law)



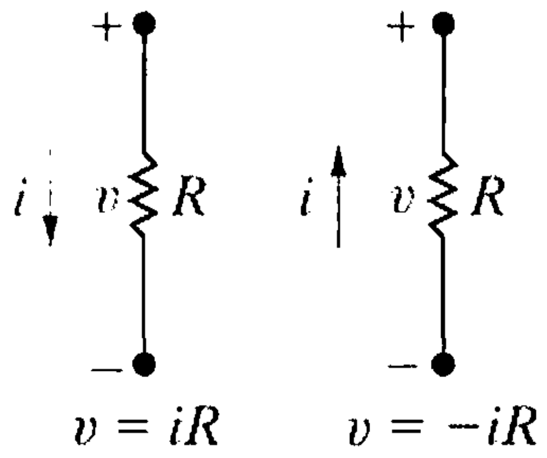
Resistance is the capacity of materials to impede the flow of current or, more specifically, the flow of electric charge. The circuit element used to model this behavior is the resistor.

For purposes of circuit analysis, we must reference the current in the resistor to the terminal voltage. We can do so in two ways: either in the direction of the voltage drop across the resistor or in the direction of the voltage rise across the resistor, as shown in Fig. If we choose the former, the relationship between the voltage and current is

$$v = iR$$ ← Ohm's Law

If we choose the second method, we must write

$$v = -iR$$



where

v = the voltage in volts,

i = the current in amperes,

R = the resistance in ohms.

Electrical Resistance (Ohm's Law)

- Ohm's law is the mathematical relationship between voltage and current for a resistor. In SI units, resistance is measured in ohms. The Greek letter omega (Ω) is the standard symbol for an ohm.

- Ohm's law expresses the voltage as a function of the current. However, expressing the current as a function of the voltage also is convenient.

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

- The reciprocal of the resistance is referred to as conductance, is symbolized by the letter G, and is measured in Siemens (S).Thus,

$$G = \frac{1}{R}\ \mathrm{S}$$

- As an example 8 Ω resistor has a conductance value of 0.125 S. In much of the professional literature, the unit used for conductance is the mho (ohm spelled backward), which is symbolized by an inverted omega (℧). Therefore we may also describe an 8 Ω resistor as having a conductance of 0.125 mho, (℧).

Electrical Resistance (Ohm's Law)

We may calculate the power at the terminals of a resistor in several ways. The first approach is to use the defining equation and simply calculate the product of the terminal voltage and current.

$$p = vi$$
$$v = iR$$
$$p = (iR)i \rightarrow \quad p = i^2R$$

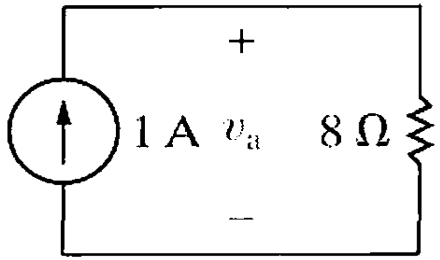
A third method of expressing the power at the terminals of a resistor is in terms of the voltage and resistance. The expression is independent of the polarity references, so

$$p = vi$$

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

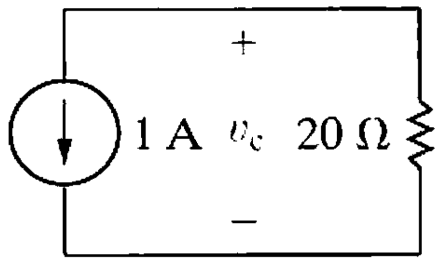
$$p = v\frac{v}{R} \quad \rightarrow p = \frac{v^2}{R}$$

Electrical Resistance (Ohm's Law)



Example: Calculating Voltage, Current, and Power for a Simple Resistive Circuit

a) Calculate the values of *v* and *i*.
b) Determine the power dissipated in each resistor.



a)
The voltage *va* in first Fig is a drop in the direction of the current in the resistor. Therefore,

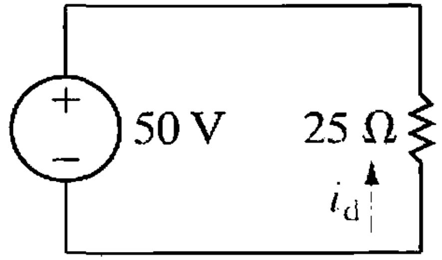
$$v_a = 1A.8\Omega = 8V$$

The voltage *vc* in second Fig. is a rise in the direction of the current in the resistor. Hence,

$$v_c = -1A.20\Omega = -20V$$

The current *id* in the 25 ohm resistor in third Fig. is in the direction of the voltage rise across the resistor. Therefore

$$i_d = \frac{-50V}{25\Omega} = -2A$$



b) The power dissipated in each of the three resistors is

$$p_{8\Omega} = 1^2.8 = 8W$$

$$p_{20\Omega} = 1^2.20 = 20W$$

$$p_{25\Omega} = (-2^2).25 = 100W$$

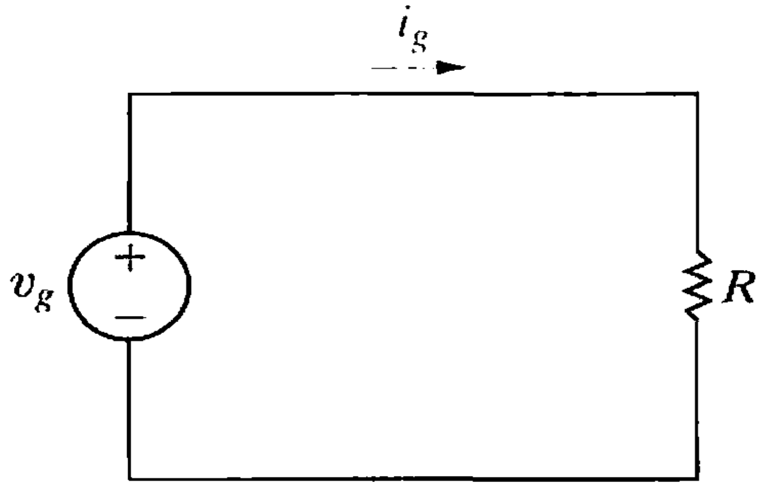
EXAMPLE

For the circuit shown

a) If v_g = 1 kV and i_g = 5 mA, find the value of *R* and the power absorbed by the resistor.

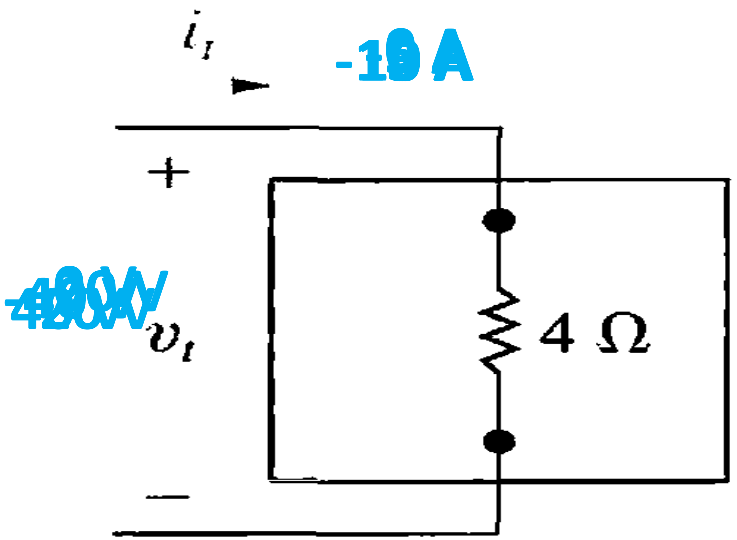
b) If i_g = 75 mA and the power delivered by the voltage source is 3 W, find v_g, *R*, and the power absorbed by the resistor.

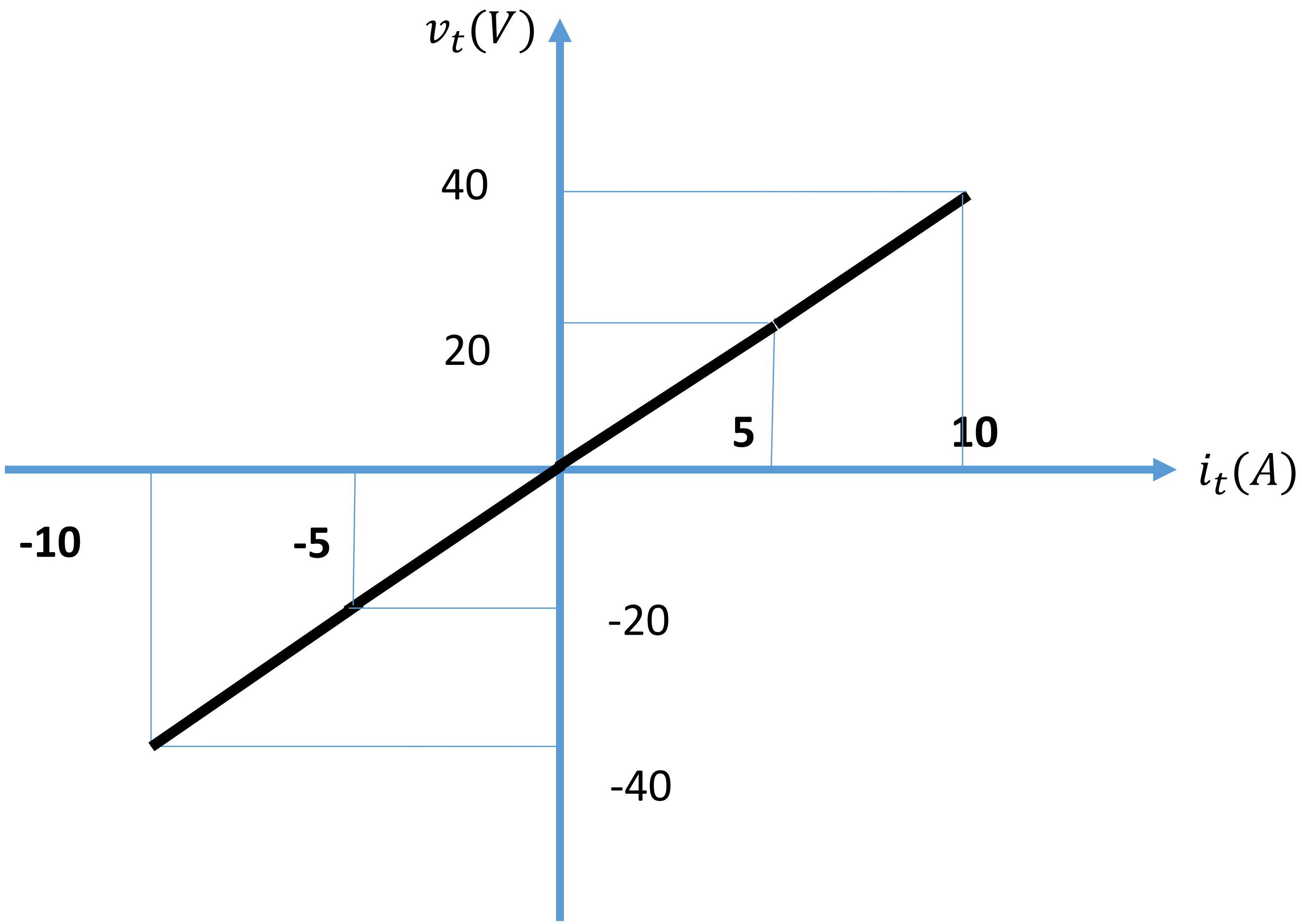
c) If *R*= 300 ohm and the power absorbed by *R* is 480 mW, find *L* and v_g.



EXAMPLE (The Voltage-Current Relationship)

$v_t(V)$	i_t(A)
-40	-10
-20	-5
0	0
20	5
40	10

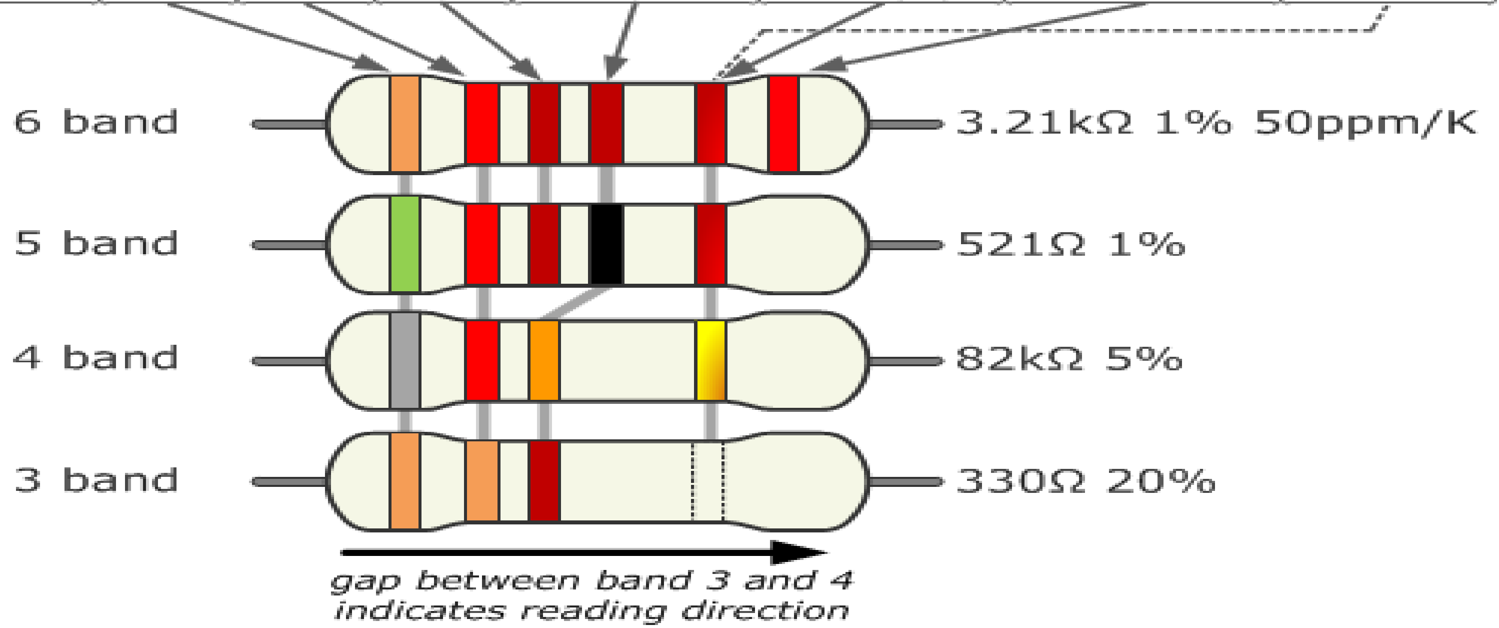




The **relationship** between **voltage**, **current**, and **resistance** is described by Ohm's law.

Resistor Color Codes

Color	Signficant figures			Multiply	Tolerance (%)	Temp. Coeff. (ppm/K)	Fail Rate (%)
black	0	0	0	x 1		250 (U)	
brown	1	1	1	x 10	1 (F)	100 (S)	1
red	2	2	2	x 100	2 (G)	50 (R)	0.1
orange	3	3	3	x 1K		15 (P)	0.01
yellow	4	4	4	x 10K		25 (Q)	0.001
green	5	5	5	x 100K	0.5 (D)	20 (Z)	
blue	6	6	6	x 1M	0.25 (C)	10 (Z)	
violet	7	7	7	x 10M	0.1 (B)	5 (M)	
grey	8	8	8	x 100M	0.05 (A)	1(K)	
white	9	9	9	x 1G			
gold			3th digit only for 5 and 6 bands	x 0.1	5 (J)		
silver				x 0.01	10 (K)		
none					20 (M)		



Terms in Circuit Diagrams

Node : Point of connection between elements.

Branch : Connection between two nodes

Loop : Closed loops in circuit diagram

Number of Branches = Number of Loops + Number of Nodes -1