WELCOME TO

FALL 2021-22

SEMESTER

EEE 2108: INTRODUCTION TO ELECTRICAL CIRCUITS

Introduction of Course Teacher

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Designation: **Professor** and **Director** of Faculty of Engineering

BSc in EEE (1993-1998): RUET (former BIT, Rajshahi)

MSc in EEE (2000-2003): Kitami Institute of Technology (KIT)

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PhD in System Engineering (2003-2006): KIT, Kitami, Hokkadio, Japan

Join at AIUB on May 2006

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Course Descriptions

- Basic concepts of DC circuit. Familiarizing with different components: Resistor, capacitor, Inductor, Voltage source, etc.
- Familiarizing with Series, Parallel and Series-parallel circuits Basic idea about alternating quantity: Period and cycle, frequency, angular velocity, angular frequency, Sinusoidal waveform. Vector Diagram.
- Ohm's Law; Total resistance of series & parallel circuits; KVL; KCL. Equation of instantaneous voltage, current and power of an R branch, L branch, C branch, RL, RC and RLC circuits. Impedance of R, L and C; Total impedances of their series or parallel combinations. Calculation of power and power factor Brief study of transients in capacitive networks.
- AC Power. Y-Delta and Delta-Y conversions; Dependent Current Source, Dependent Voltage Source; Network Theorems for DC and AC circuits: Superposition theorem Network Theorems for DC and AC circuits. Electromagnetism, Flemings hand rules,
- DC generator and DC motor, Transformer, Induction motor, Synchronous generator, Alternator, Stepper Motor, Induction Motor, Universal Motor, Servo Motor, Permanent-magnet Synchronous motor, hysteresis motor, Reluctance motor, Linear motor

Text Books

[1] R. L. Boylestad, “Introductory Circuit Analysis,” 12hEdition, Pearson Education, Inc.

[2] B. L. Theraja, A. K. Theraja, “A Textbook of ELECTRICAL TECHNOLOGY in SI Units Volume II, AC & DC Machines,” S. Chand & Company Ltd.

[3] V.K. Mehta, Rohit Mehta, “Principles of Electrical Machines,” 2nd Edition, S. Chand & Company Ltd.

[4] Jack Rosenblatt, M. Harold Friedman, “Direct and Alternating Current Machinery,” C.E. Merrill Publishing Company, 1984

Reference Books

[**1**] Robert P. Ward, “Introduction to Electrical Engineering”, 3rd Edition, Prentice Hall Inc.

[**2**] Charles K. Alexander & Mathew N.O. Sadiku, “Fundamentals of Electric Circuits”, 3rd edition, The McGraw-Hill companies.

[**3**] Stephen J. Chapman, “Electric Machinery Fundamentals” - 3rd Edition, McGraw- Hill International Editions

[**4**] Irving L. Kosow, “Electrical Machinery and Transformers”- Second Edition, Prentice – Hall India Pvt. Limited.

[**5**] S. K. Bhattacharya, “Electrical Machines”, McGraw Hill Education, 2014

[**6**] J. David Irwin and R. mark Nelms, “Basic Engineering Circuit Analysis”, Eleventh Edition, John Wiley & Sons, Inc. , 2015.

Course Outcomes

COs	Details	Level of Domain				Assessed Program Outcomes (POI)#
		C	P	A	S	
CO1	Apply information and concepts in basic electrical properties and atomic structure of materials, flow of charge, effects of temperature on resistance of a material, etc. with the familiarity of issues to calculate different electrical parameters in circuits containing both DC and AC sources.	3			S	P.a.1.C3
CO2	Apply different laws, rules, methods of analysis, and theorems for the calculation of several electrical parameters in circuits containing both DC and AC sources.	3			S	P.a.3.C3
CO3	Apply information and concepts of mathematics to solve single Phase AC Circuits, represent the alternating quantities and determine the power in these circuits with a range of conflicting requirements.	3			S	P.a.2.C3
CO4	Apply information and concepts of rotating electrical machines in solving problems relating with voltage, current, frequency, speed, torque, power, efficiency, and flux for both AC and DC machines.	3			S	P.a.3.C3

C: Cognitive; P: Psychomotor; A: Affective; S: Soft-skills (CT: Critical Thinking), SL: Strongly linked; ML: Moderately linked; WL: Weakly linked

 # For details please check the appendix A

Mid-Term Assessment

Attendance		**10%**
Quizzes (Best 3)	Quiz 1: 10%	**30%**
	Quiz 2: 10%	
	Quiz 3: 10%	
	Quiz 4: 10%	
Assignments (Best 2)	Assignment 1: 10%	**20%**
	Assignment 2: 10%	
	Assignment 3: 10%	
Viva		20%
Mid-Term Exam		20%
Total		100%

Final-Term Assessment

Attendance		**10%**
Quizzes (Best 3)	Quiz 1: 10%	**30%**
	Quiz 2: 10%	
	Quiz 3: 10%	
	Quiz 4: 10%	
Assignments (Best 2)	Assignment 1: 10%	**20%**
	Assignment 2: 10%	
	Assignment 3: 10%	
Presentation		20%
Final Exam		20%
Total		100%

Grand Total

Mid Term: : 40%

Final Term: : 60%

Total: : 100%

Attendance

- Attendance will be downloaded from MS Teams or call your name for attendance after 30 minutes from the time of starting class.

Viva Mid Term

Viva Question will be asked individually from the basic or fundamental theory of Mid-Term Syllabus.

Rubrics for Viva Marking

Q/A -01	Q/A -02	Q/A -03	Q/A -04	Q/A -05	Total
2	2	2	2	2	10

Presentation Final Term

Individual Person Presents individual Topics which will be informed on time.

Rubrics for Presentation Marking

Presentation Skill	Theory Explain	Problem Solution	Clarity Understanding	Time Management	Total
2	2	2	2	2	10

Assignment

Assignment will be given based on your ID number

Instruction Related to Used Variables:

Note that this assignment uses the variables m_1, m_2, m_3, m_4, and m_5, which are the five digits of middle of your student ID. For example, if your student ID is: 09-15985-3, then you must consider:

$m_1=1$; $m_2=5$; $m_3=9$; $m_4=8$; $m_5=5$

Write in the following Table the variables value according to your ID:

m_1	m_2	m_3	m_4	m_5

Problem 1: Using the concept of series resonance design a radio receiver tuning circuit to receive FM radio channels (87.5 MHz – 108.0 MHz) effectively. Your designed circuit should fulfill the following requirements:

(*i*) The operating voltage rms value should be ($5 + 0.5\times m_3$) V.

(*ii*) The maximum power consumption should not be more than ($50 + 10\times m_5$) W.

(*iii*) The selectivity of the circuit should be more than ($10+0.5m_4$).

(*iv*) Variable inductors/capacitors can be used.

Two Marks will be reduced for each day delay of submission

Academic Calendar

ACADEMIC CALENDAR – Year 2021-2022

Fall 2021-22

14 Weeks
Online – Microsoft Teams

Regular Students and Masters' Freshman Class: September 12, 2021
Undergraduate Freshman Class: September 26, 2021

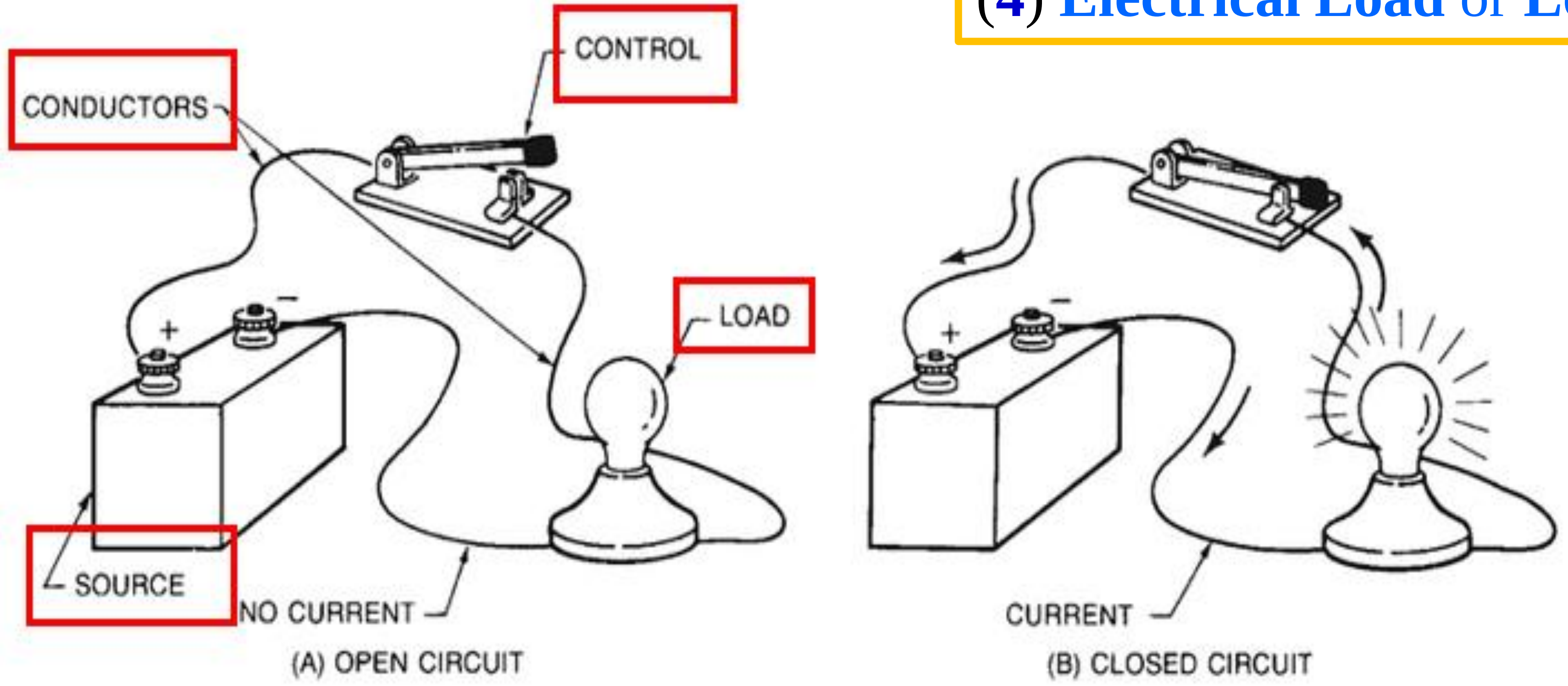
2021		
Sep	12	First Day of Classes (Regular and Masters' Freshman Classes)
	16 & 19	Adding/ Dropping
	19	Submission of TSF and course description (Regular and Masters' Freshman Classes)
	26	**Automatic conversion of UW, I, blank grades of Summer 2020-21 Semester to F**
Oct	21	Submission of mid semester assessment plan to VC's office
	16 – 21	Mid Semester Laboratory Assessment (Regular and Masters' Freshman Courses)
	23 – 28	Mid Semester Assessment (Regular and Masters' Freshman Courses)
	23 – 28	Mid Semester Laboratory Assessment (Undergraduate Freshman Courses only)
	30 – Nov 4	Mid Semester Assessment (Undergraduate Freshman Courses only)
Nov	4	Submission of mid semester grades (Regular and Masters' Freshman Classes)
	11	Submission of mid semester grades (Undergraduate Freshman Courses only)
	21 - 25	TPE
	25	Mid semester Grades Locked
	21 - 25	Pre-registration for Spring 2021-22
	27 – Dec 9	Final Laboratory Assessment
	9	Submission of original final assessment plan to VC's office
	4 - 18	Final Assessment
	26	Submission of Final Grades
	Dec 19 – Jan 15, 2022	Semester break; Release of grades Final Registration for Spring 2021-22
	Jan 8, 2022	Final Grades Locked
	Jan 27, 2022	Automatic conversion of UW, I grades of this semester to F

Basic of Electrical System

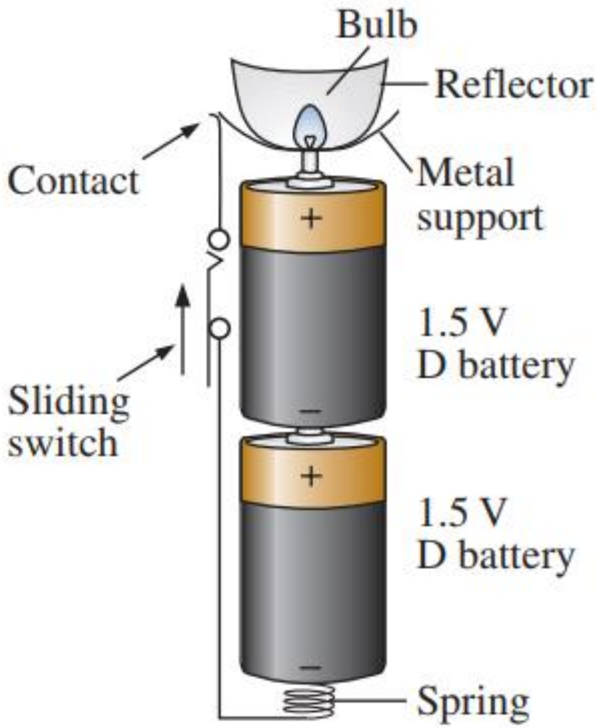
Electrical System

An **electric circuit** or **network** is an interconnection of electrical elements.

The components or elements of an electrical system are: (**1**) **Source**, (**2**) **Conductors** or **Wires**, (**3**) **Control Elements** or **Switches**, and (**4**) **Electrical Load** or **Load**



A closed path is required to flow of current.



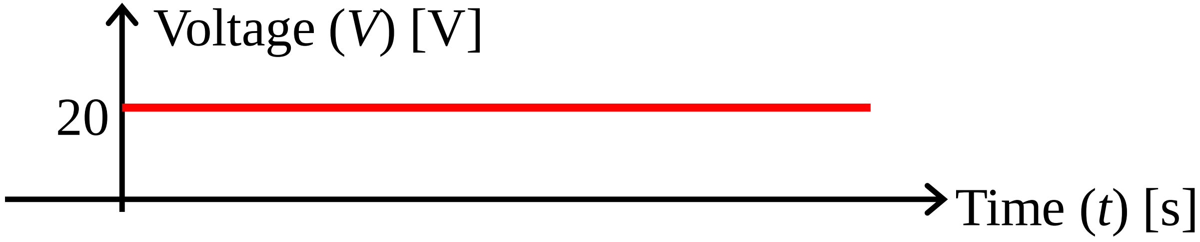
Electrical Energy Sources

In electrical system has mainly two types of source:

DC (Direct Current) Source

AC (Alternating Current) Source

Graphical representation of DC Source



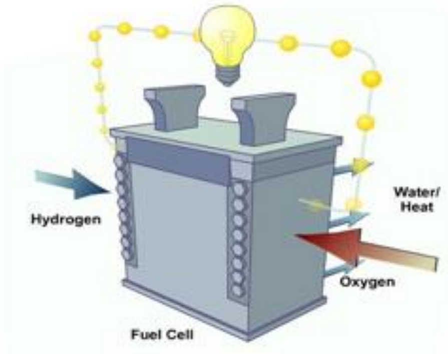
DC Source

- ❑ Battery (DC)
- ❑ DC Generator
- ❑ Lab DC Power Supply
- ❑ Solar (PV) Cell
- ❑ Fuel Cell

Battery (DC)

Solar Cell (DC)

Lab Power Supply (DC)

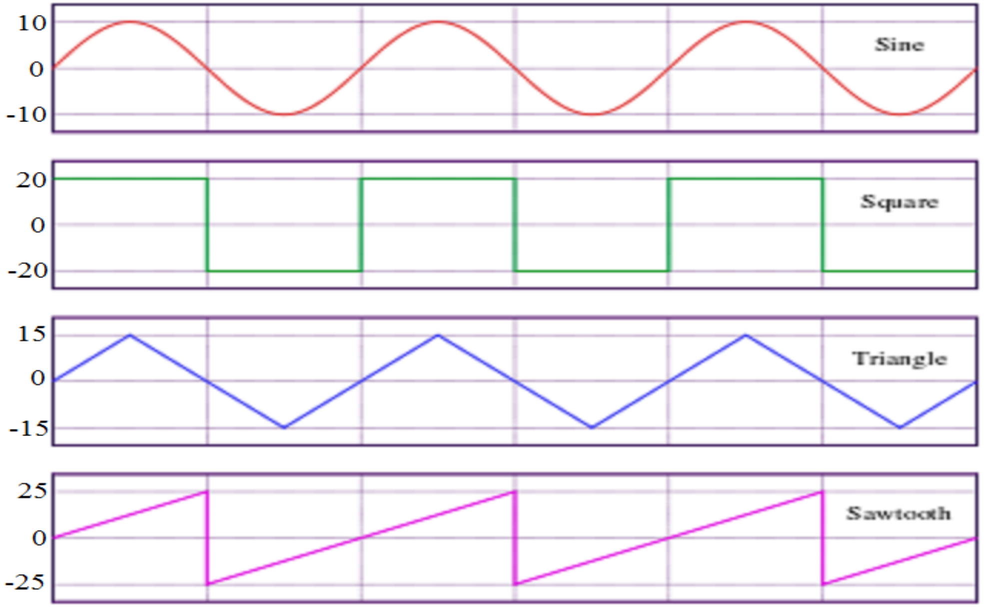


Fuel Cell (DC)

Electrical Energy Sources

AC Source

- AC Generator in power Plant
- Lab AC Power Supply
- Portable AC Generator
- Standby AC Generator
- Wind Generation
- Biogas Power Plant

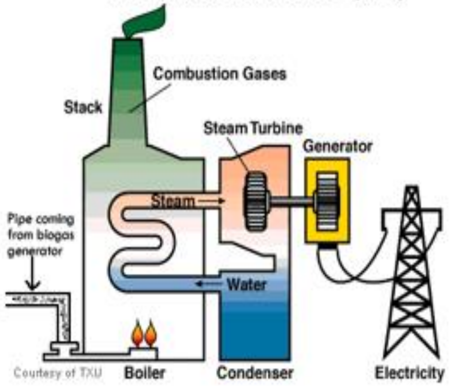


Generator in Power Plant (AC)

Portable Generator (AC)

Lab Power Supply (AC)

Wind Generation (AC)

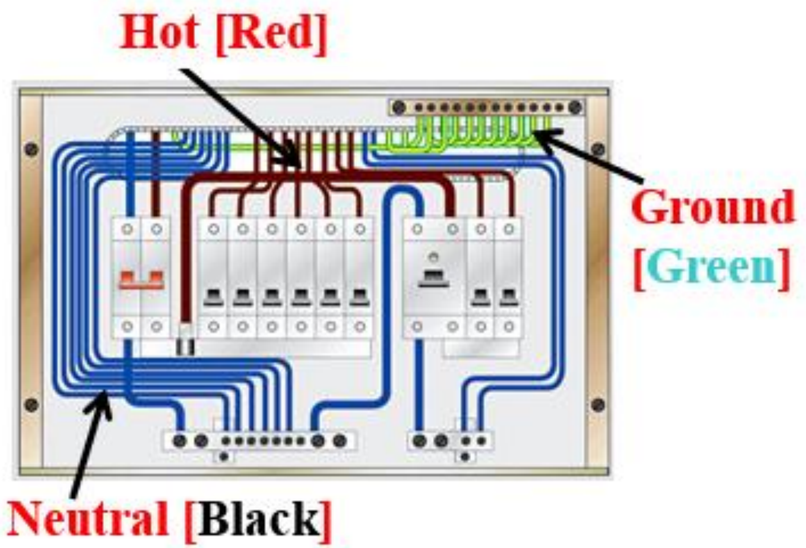


Biogas Power Plant (AC)

Standby Generator (AC)

Conductors or Wires

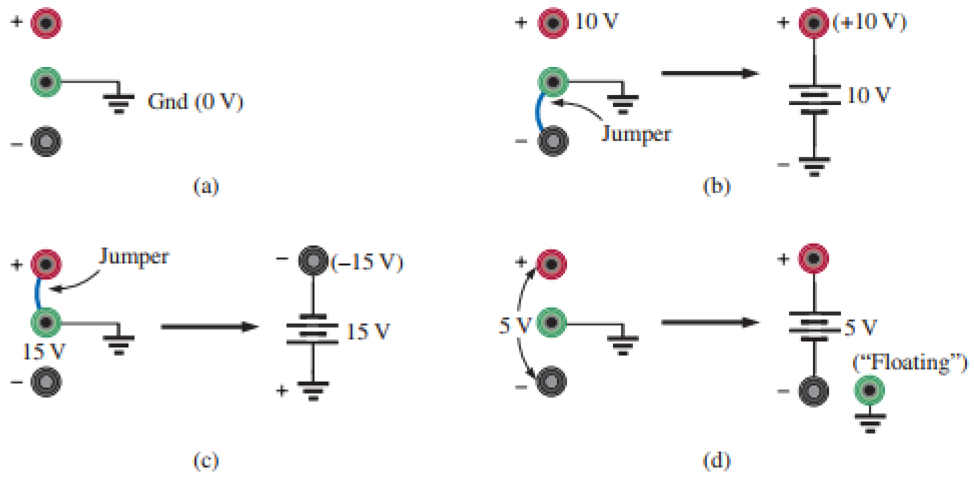
In any electrical circuit mainly three types of wires are used:

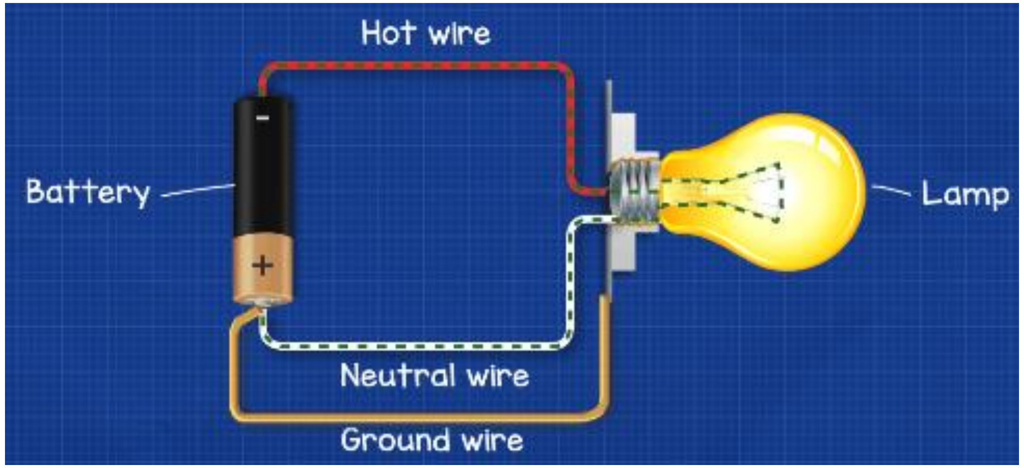


Hot or Positive or Phase wire: Hot wire carries the electricity from the power supply to the load

Neutral or Negative wire: Neutral wire carries the used electricity back to the power supply

Grounding or Earthing: Connected to any metal parts in an appliance such as a microwave oven or coffee pot. This is a safety feature, in case the hot or neutral wires somehow come in contact with metal parts. Connecting the metal parts to earth ground eliminates the shock hazard in the event of a short circuit





Control Elements or Switches

Control Elements or Switches are used to turn-on or turn-off a circuit.

Fuses

Relay

Switches

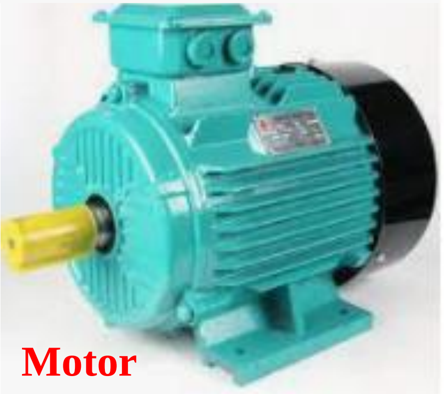
Circuit Breaker

Electrical Load

Electrical Load: The devices which consume or absorb or receive the electrical energy is called electrical load.

Water Heater

Hair Dryer

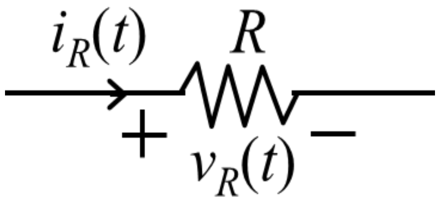


Load Represent by Passive Elements

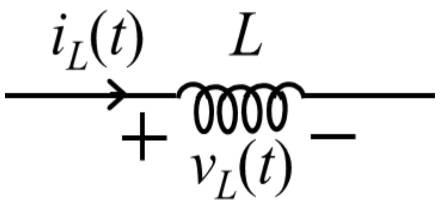
Loads can be represented by the combination of passive elements such as Resistor, Inductor, and Capacitor.

Passive Elements As a Load: Resistance (R), Inductance (L) and Capacitance (C)

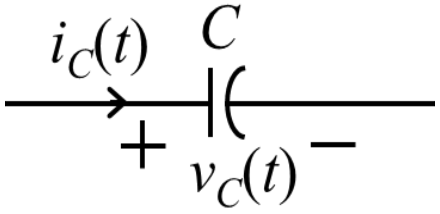
Combination of these elements: Series, Parallel and Series-Parallel



Resistance measured in **ohm** (Ω)

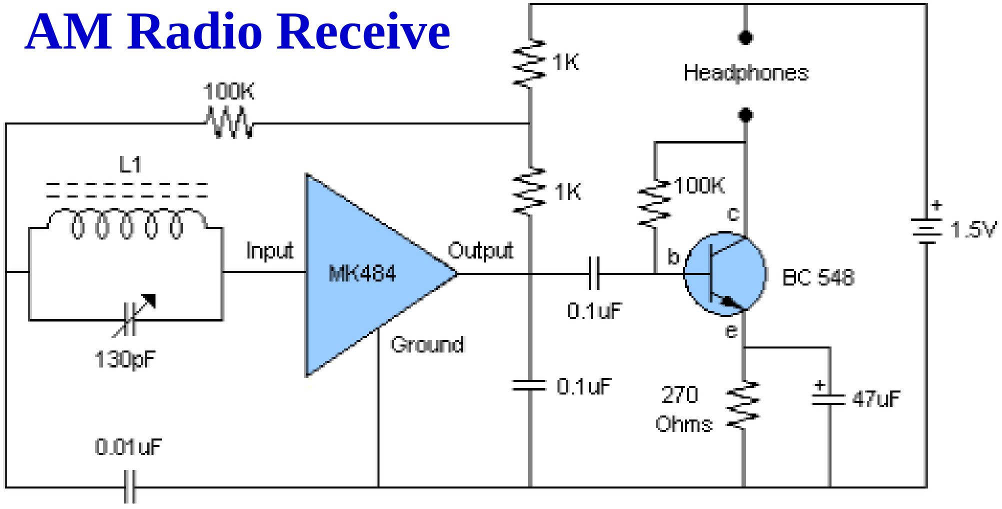


Inductance measured in **Henry** (H)



Capacitance measured in **Farad** (F)

AM Radio Receive



1.6 Power of Ten

The International System of Units [SI] prefixes

1.6 POWERS OF TEN

$$1 = 10^0 \qquad 1/10 = 0.1 = 10^{-1}$$
$$10 = 10^1 \qquad 1/100 = 0.01 = 10^{-2}$$
$$100 = 10^2 \qquad 1/1000 = 0.001 = 10^{-3}$$
$$1000 = 10^3 \qquad 1/10{,}000 = 0.0001 = 10^{-4}$$

EXAMPLE 1.10

a. 1,000,000 ohms $= 1 \times 10^6$ ohms = 1 megohm (MΩ)

b. 100,000 meters $= 100 \times 10^3$ meters = 100 kilometers (km)

c. 0.0001 second $= 0.1 \times 10^{-3}$ second = 0.1 millisecond (ms)

d. 0.000001 farad $= 1 \times 10^{-6}$ farad = 1 microfarad (μF)

Observation:

When convert smaller to larger decimal point shift to left.

When convert larger to smaller decimal point shift to right.

TABLE 1.2

Multiplication Factors	Prefix	SI Symbol
1 000 000 000 000 000 000 = 10^{18}	exa	E
1 000 000 000 000 000 = 10^{15}	peta	P
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
1 00 = 10^{2}	hector	h
1 0 = 10^{1}	deka	da
1 = 10^{0}	unit	unit
0.1= 10^{-1}	deci	d
0.0 1= 10^{-2}	centi	c
0.001= 10^{-3}	mili	m
0.000 001= 10^{-6}	micro	μ
0.000 000 001= 10^{-9}	nono	n
0.000 000 000 001= 10^{-12}	pico	p
0.000 000 000 000 001= 10^{-15}	femto	f
0.000 000 000 000 000 001= 10^{-18}	atto	a

1.8 CONVERSION BETWEEN LEVELS OF POWERS OF TEN

EXAMPLE 1.12 a. Convert 20 kHz to megahertz. b. Convert 0.002 km to millimeters.

Solutions:

a. In the power-of-ten format:

$$20\text{ kHz} = 20 \times 10^3\text{ Hz}$$

The conversion requires that we find the multiplying factor to appear in the space below:

$$20 \times 10^3\text{ Hz} \Rightarrow \underline{\quad} \times 10^6\text{ Hz}$$

Increase by 3

Decrease by 3

Since the power of ten will be *increased* by a factor of *three,* the multiplying factor must be *decreased* by moving the decimal point *three* places to the left, as shown below:

$$\underbrace{020.}_{3} = 0.02$$

and $\qquad 20 \times 10^3\text{ Hz} = 0.02 \times 10^6\text{ Hz} = \mathbf{0.02\ MHz}$

When convert smaller to larger decimal point shift to left.

b. In the power-of-ten format:

$$0.002\text{ km} = 0.002 \times 10^3\text{ m}$$

Reduce by 6

$$0.002 \times 10^3\text{ m} \Rightarrow \underline{\quad} \times 10^{-3}\text{ m}$$

Increase by 6

In this example we have to be very careful because the difference between +3 and −3 is a factor of 6, requiring that the multiplying factor be modified as follows:

$$0.\underbrace{002000}_{6} = 2000$$

and $\qquad 0.002 \times 10^3\text{ m} = 2000 \times 10^{-3}\text{ m} = \mathbf{2000\ mm}$

When convert larger to smaller decimal point shift to right.

EXAMPLE 1.1.1 [Similar of Problem 25]: Perform the following conversions:

a. 2000 μs to milliseconds **b. 0.04 ms to microseconds** **c.** 0.06 μF to nanofarads

Solution: **a**. In the power of ten format: $2000\ \mu s = 2000 \times 10^{-6}\ s$ $2000 \times 10^{-6}\ s = \underline{\hspace{3em}} \times 10^{-3}\ s$

Since the power of ten will be ***increased*** by a factor of *three*, the multiplying factor must be ***decreased*** by moving the decimal point *three* places to the left, as follows:

$$2000 \times 10^{-6}\ s = \underline{\mathbf{2.0}}\ ms$$

b. In the power of ten format: $0.04\ ms = 0.04 \times 10^{-3}\ s$ $0.04 \times 10^{-3}\ s = \underline{\hspace{3em}} \times 10^{-6}\ s$

Since the power of ten will be ***reduced*** by a factor of *three*, the multiplying factor must be ***increased*** by moving the decimal point *three* places to the right, as follows:

$$0.04 \times 10^{-3}\ s = \underline{\mathbf{40}}\ \mu s$$

c. In the power of ten format: $0.06\ \mu F = 0.06 \times 10^{-6}\ F$ $0.06 \times 10^{-6}\ F = \underline{\hspace{3em}} \times 10^{-9}\ F$

Since the power of ten will be ***reduced*** by a factor of *three*, the multiplying factor must be ***increased*** by moving the decimal point *three* places to the right, as follows:

$$0.06 \times 10^{-6}\ F = \underline{\mathbf{60}}\ nF$$

EXAMPLE 1.1.2 [Similar of Problem 25]: Perform the following conversions:

a. 8400 ps to microseconds **b.** 0.006 km to milimeters **c. 260 × 10^3 mm to kilometers**

Solution: **a**. In the power of ten format: 8400 ps = 8400×10^{-12} s

$8400 \times 10^{-12}\text{ s} = \underline{\qquad\qquad} \times 10^{-6}\text{ s}$

Since the power of ten will be ***increased*** by a factor of ***six***, the multiplying factor must be ***decreased*** by moving the decimal point ***six*** places to the left, as follows:

$$8400 \times 10^{-12}\text{ s} = \underline{\mathbf{0.0084}}\ \mu\text{s}$$

b. In the power of ten format: 0.006 km = 0.006×10^3 m

$0.006 \times 10^3\text{ m} = \underline{\qquad\qquad} \times 10^{-3}\text{ m}$

Since the power of ten will be ***reduced*** by a factor of ***six***, the multiplying factor must be ***increased*** by moving the decimal point ***six*** places to the right, as follows:

$$0.006 \times 10^3\text{ m} = \underline{\mathbf{6000}}\text{ m}$$

c. In the power of ten format: $260 \times 10^3\text{ mm} = 260 \times 10^3 \times 10^{-3}\text{ m} = 260\text{ m}$

$260 \times 10^0\text{ m} = \underline{\qquad\qquad} \times 10^3\text{ m}$

Since the power of ten will be ***increased*** by a factor of ***three***, the multiplying factor must be ***decreased*** by moving the decimal point ***three*** places to the left, as follows:

$$260 \times 10^0\text{ m} = \underline{\mathbf{0.26}}\text{ km}$$

Test Your Knowledge

Problem 1.1.1: Perform the following conversions:

a. 80 mm to meters

b. 4×10^{-3} km to millimeters

Practice Book Problem [SECTION 1.8 and SECTION 1.9] Problems: 24, 26 and 27