Wish you all Very Happy New Year

Course: Basic Electronics (EC21101)

Course Instructors:
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MON(10:00-10:55) , WED(08:00-08:55) , WED(09:00-09:55) , THURS(10:00-10:55)

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Office: R314, ECE Dept, Discussion time: Friday 5pm

Course Breakup

- Mid-Semester Examination : 30 Marks
- End-Semester Examination: 50 Marks
- TA: 20 Marks
  - Two class Tests (14 marks)
  - Tutorial (3 marks)
  - Attendance and interaction in class (3 marks)

Mid Semester Examination: 18-26 Feb. 2019
End-Semester Examination: 22-30 April 2019

Course contents

- Signal, noise, system, RL, RC filter circuit etc.,
- Intrinsic, extrinsic semiconductor, drift & diffusion current, p-n junction, forward bias/ reverse bias, I-V equation (without proof), diode model (ideal, piece wise linear etc), Zener diode characteristics;
- half wave, full wave rectifier, bridge rectifier, ripple, Zener diode circuit (voltage ref, regulation), filter, clipper, clamper, multi diode circuit
- BJT Basics, alpha-beta relation, I-V equation with different regions, DC circuit analysis, common emitter circuit with and without emitter resistor, BJT amplifier, load line, Q point, small signal equivalent circuit, common emitter amplifier (gain, input resistance, output resistance).

Course contents

- OPAMP basic, virtual ground, ideal properties, inverting, non inverting, buffer, differential amplifier, CMRR (all these with ideal and non ideal OPAMP gain), integrator, differentiator.
- Digital electronics- number system, Digital gates (symbol, truth table), universal gate, sum of product, product of sum, Karnaugh map, RS/D/T Flip Flop.
- MOSFET basic structure, IV equation (no proof) with different regions, depletion mode, enhancement mode, channel length modulation, DC circuit analysis, common source circuit with and without source resistor
- MOSFET amplifier, load line, Q point, small signal equivalent circuit, common source amplifier (gain, input resistance, output resistance).

Basic Electronics Lab

- Measurement of resistance, classification of capacitors, diode testing
- Familiarization with signal generator, oscilloscope and studies of RC, CR and RL circuits
- Studies of rectifiers and power supply
- Studies of small signal BJT CE amplifiers
- Studies of analog circuits using OP-AMP
- Studies of Logic gates

References

TEXT BOOK

- **Donald A. Neamen, *Electronic Circuits-Analysis and Design***
- Sedra and Smith, *Microelectronics* Text book (some portion).

Reference BOOK

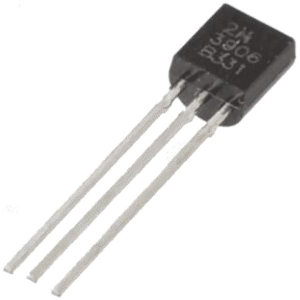
- Milliman and Halikas, *Integrated Electronics*, Reference book
- Raza Vi, *Fundamentals of Microelectronics*, Reference book

Electronics: History & It's Application

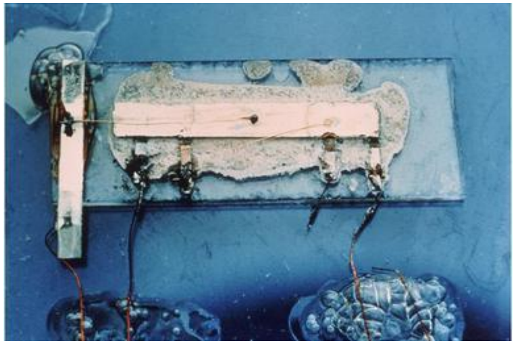
Electronics era came into existence with the invention of vacuum diode in the year 1897.

Vacuum Diode (1897) – John Ambrose Fleming

Transistor (1948) – John Bardeen, Walter Brattain and William Shockley in Bell Labs (Nobel in 1956)



First transistor

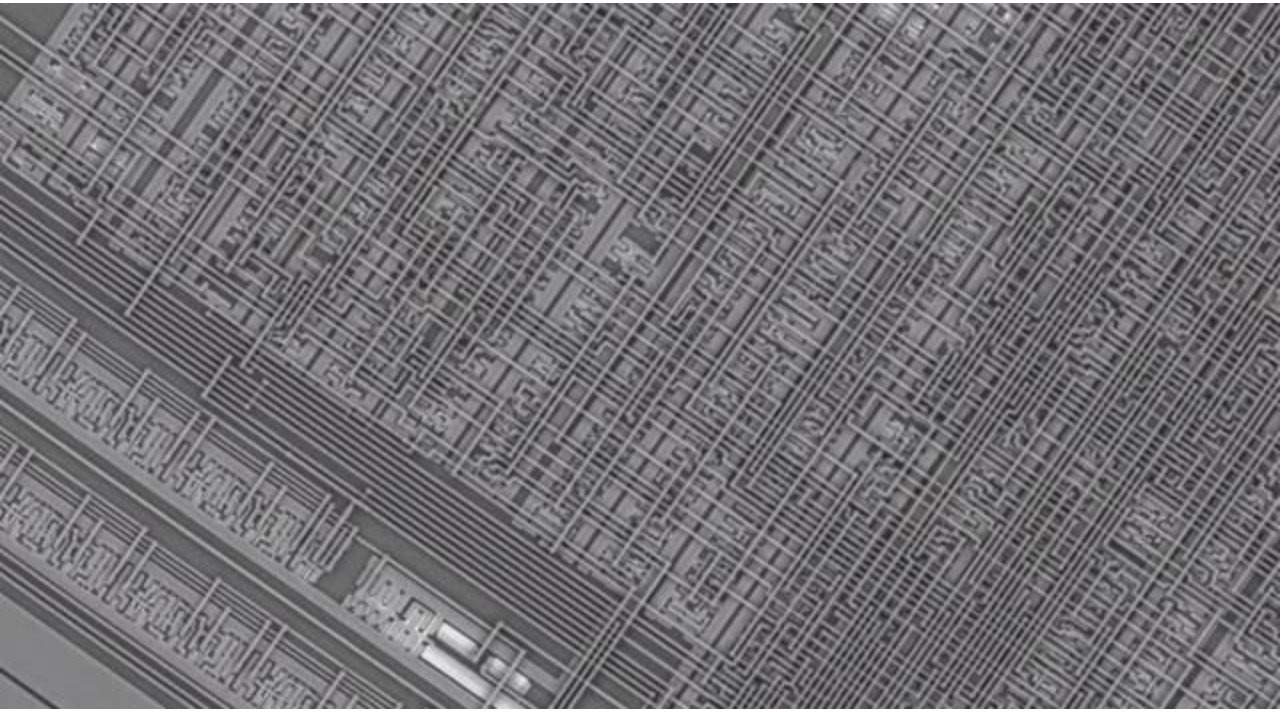


First IC

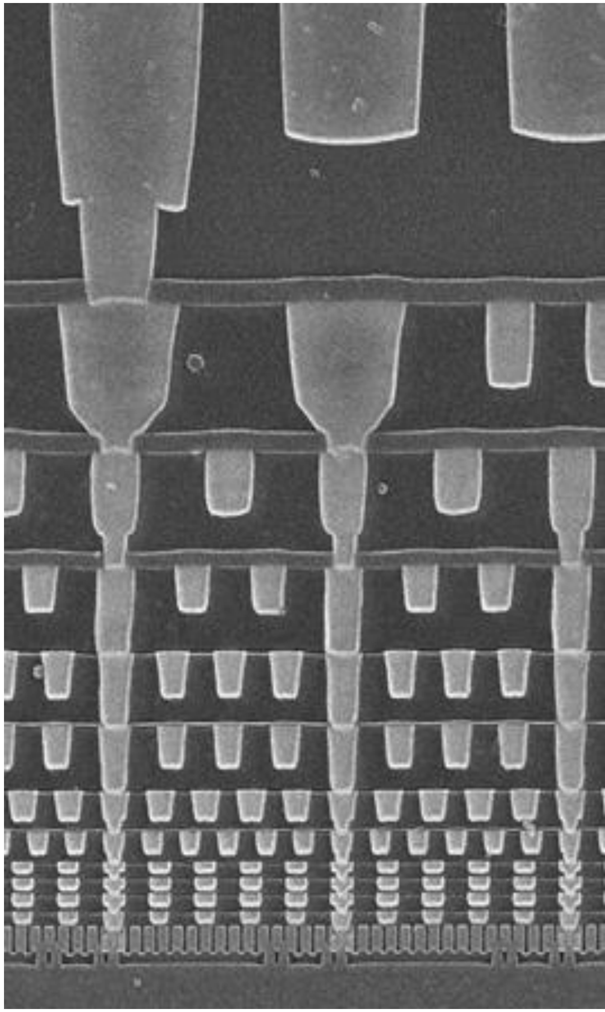
Integrated Circuit (1958) – Jack Kilby
(Nobel in 2000)

Electronics: History & It's Application

Billions of transistors in a single chip



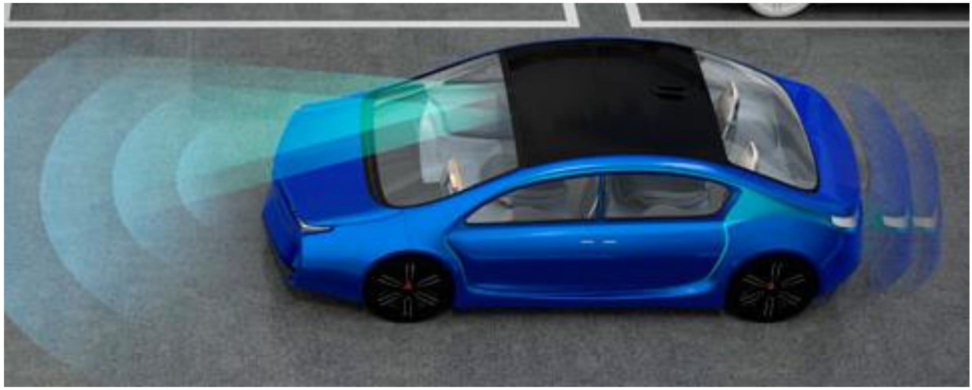
Top view (SEM) of an IC chip



Cross-section view (SEM) of an IC chip

Electronics: History & It's Application

Consumer Electronics



autonomous vehicle

Defence and Aerospace

Communication

Metrology & Sensing

Electronics Application: Example

Cell Phone charger

Electronics Application: Example

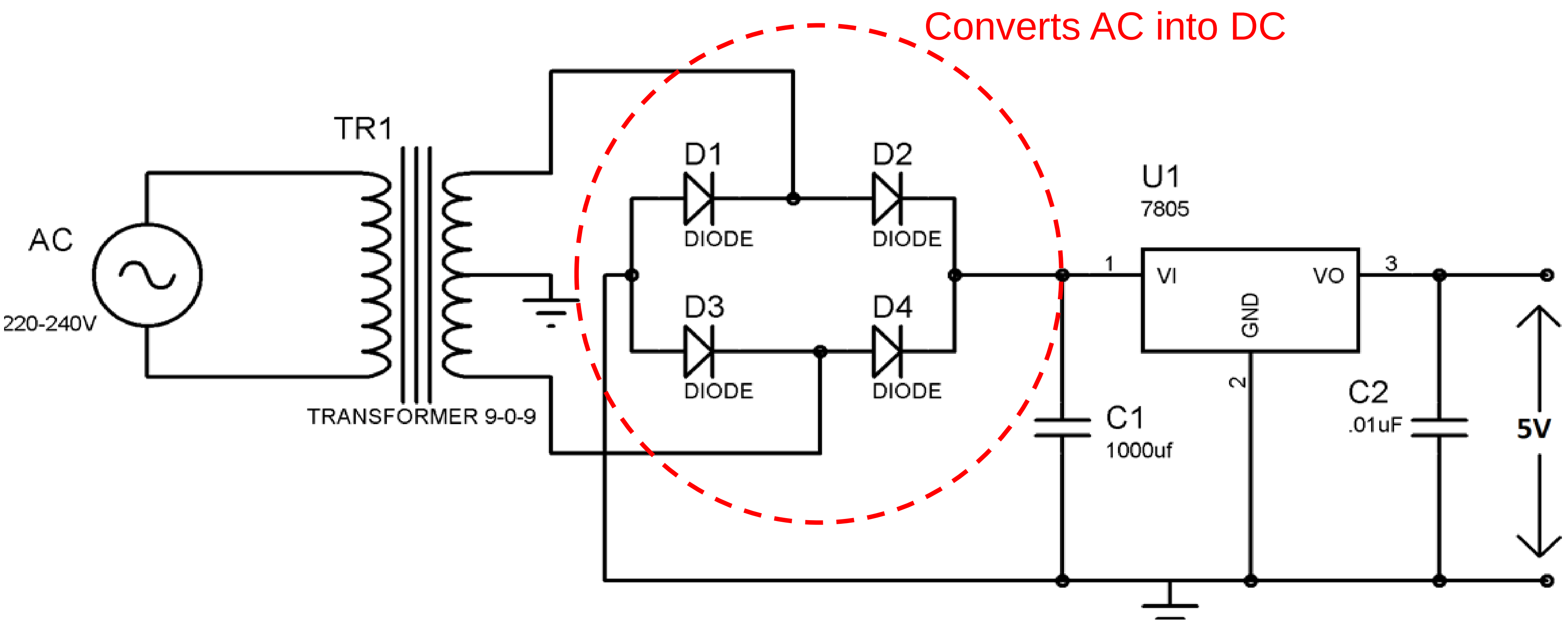
Cell Phone charger

Line voltage : 220V 50Hz

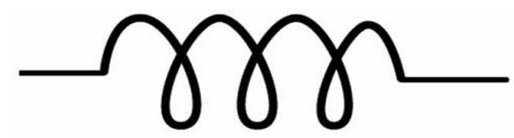
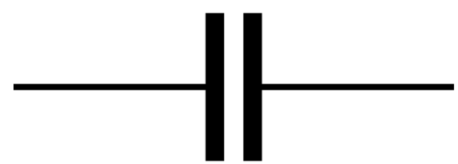
Can you build a charger with known electrical components, e.g. resistor, capacitor and inductor?

Electronics Application: Example

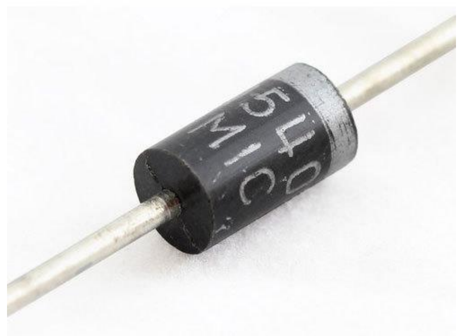
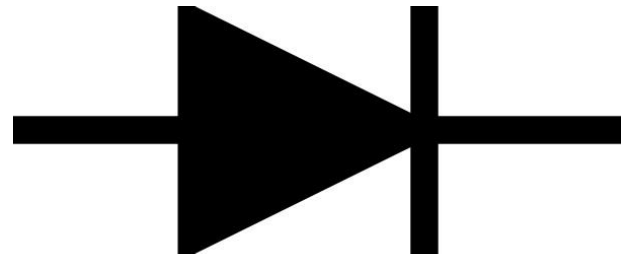
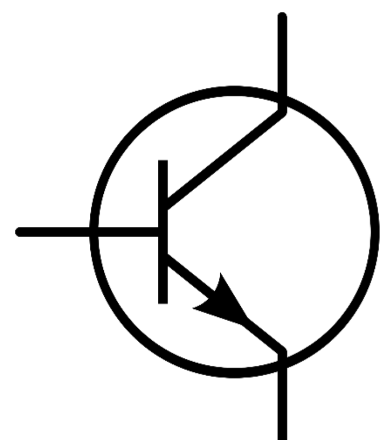
Cell Phone charger



Components of an Electronics Circuit

	Image	Symbol
Resistor		
Inductor		
Capacitor		

Components of an Electronics Circuit

	Image	Symbol
Diode		
Transistor		

Components of an Electronics Circuit

Passive components: components which can not supply energy to the circuit themselves.

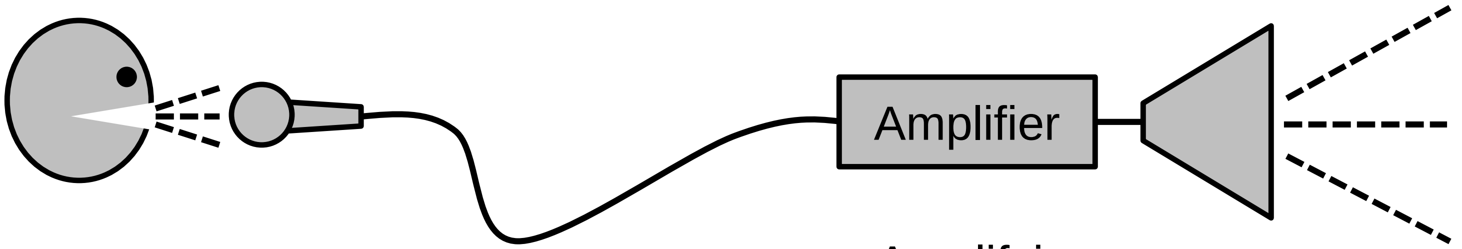
Resistor, Capacitor, Inductor etc.

Active components: components which can supply energy to the circuit or control the energy flow.

Battery, Transistor, AC signal generator, Diode etc.

Electronic System

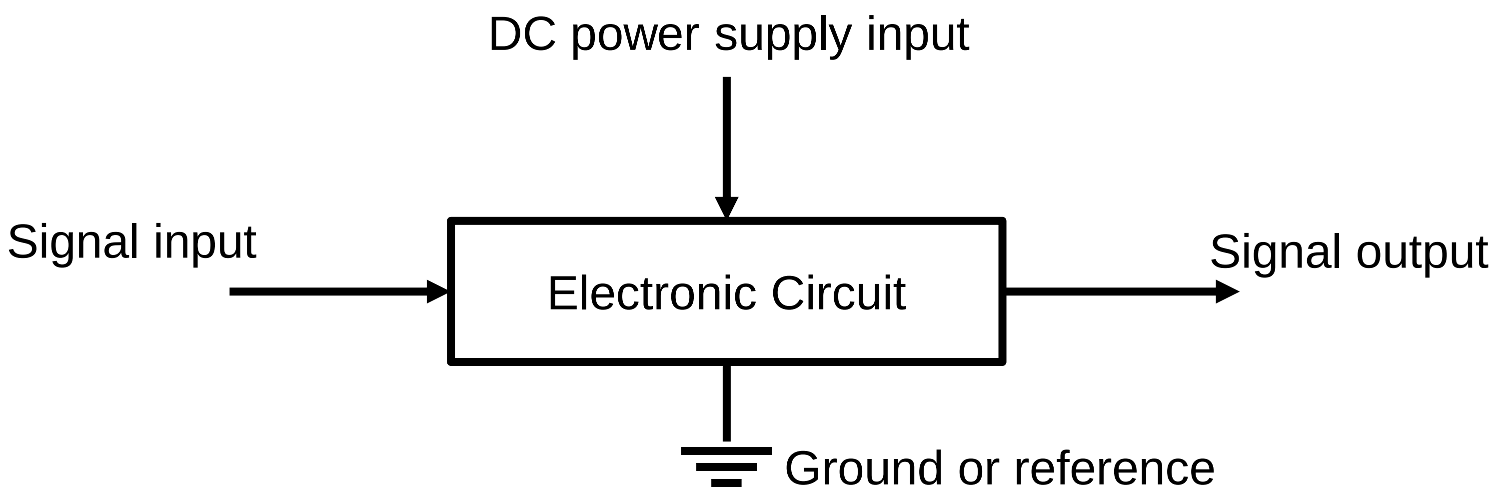
Consists of multiple passive and active components to alter or modify an incoming electrical signal



Converting sound waves into electrical signal

Amplifying electrical signal

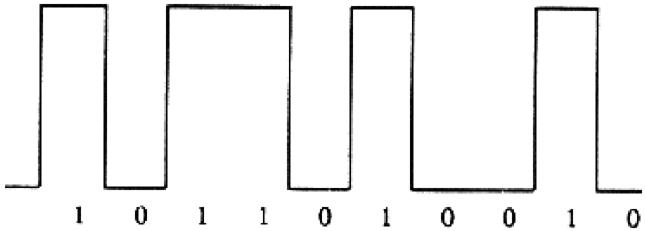
Electronic System



Analog Electronic Circuit:
The signals are continuously variable

Voice signal

Digital Electronic Circuit:
The signals usually takes two or more levels

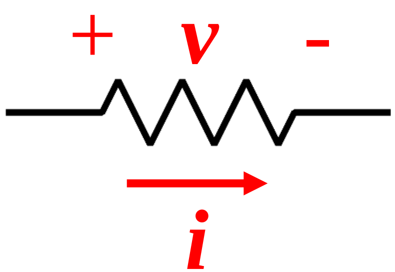


Binary signal

Circuits with passive components

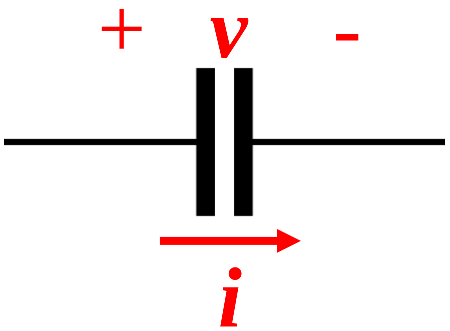
Current-voltage relationship

Resistor



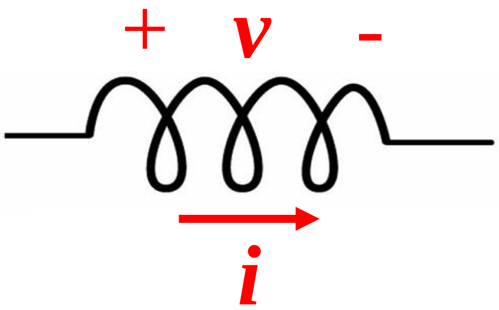
$$v = iR$$

Capacitor



$$i = C\frac{dv}{dt}$$

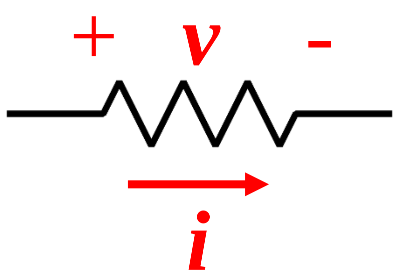
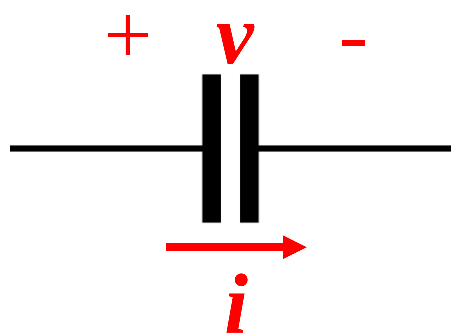
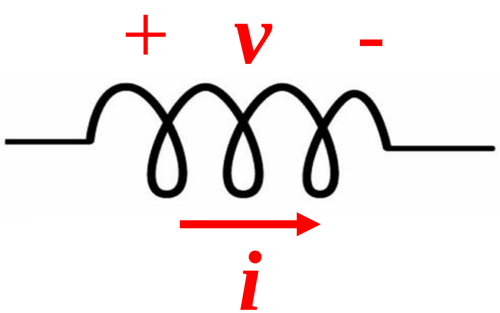
Inductor



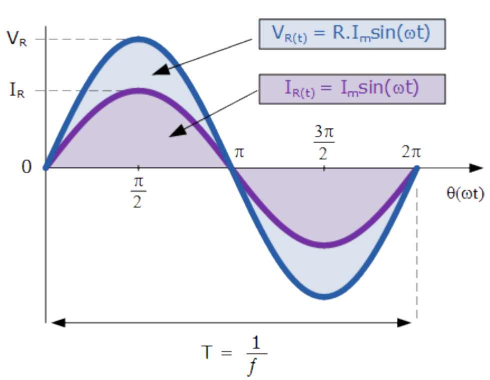
$$v = L\frac{di}{dt}$$

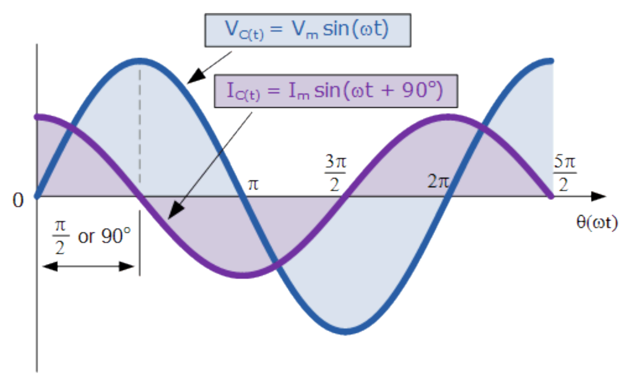
Circuits with passive components

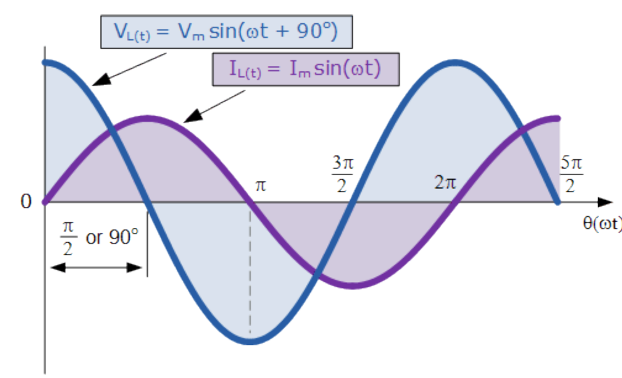
Impedance

Resistor	Capacitor	Inductor
		

$$Z_R = R \qquad Z_C = -j\frac{1}{\omega C} \qquad Z_L = j\omega L$$

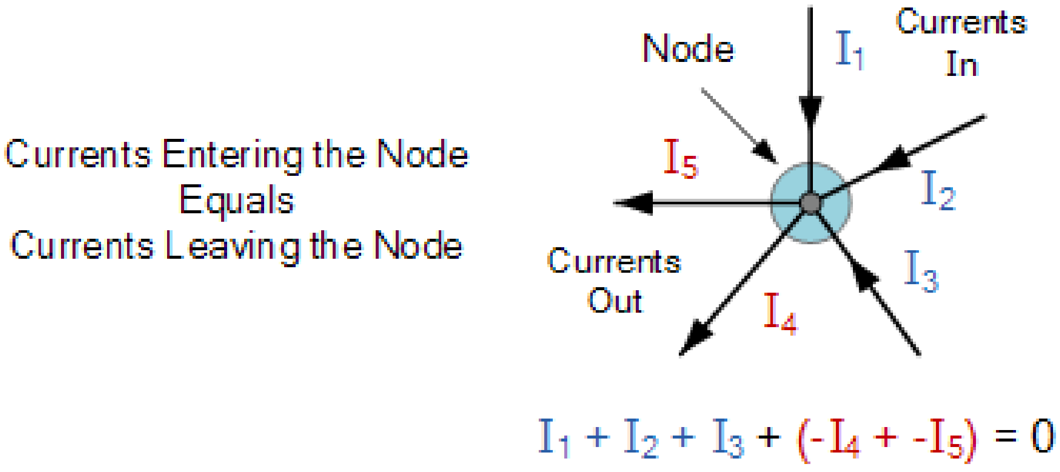




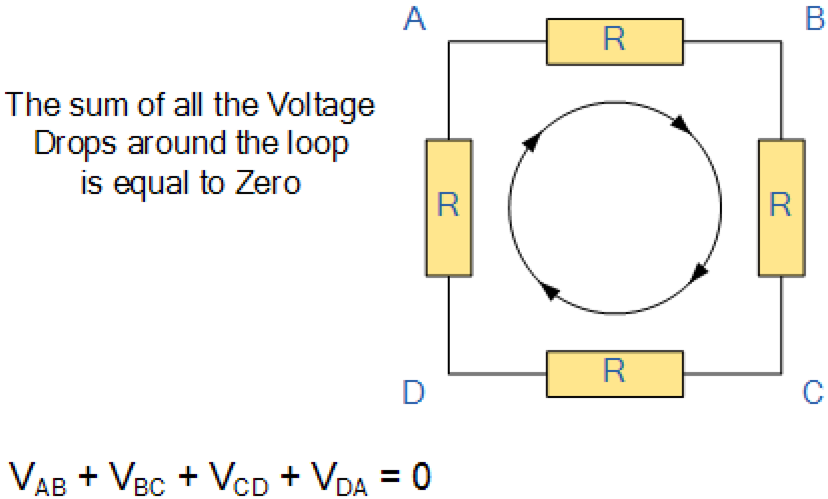


Kirchhoffs Circuit Law

Kirchhoffs Current Law

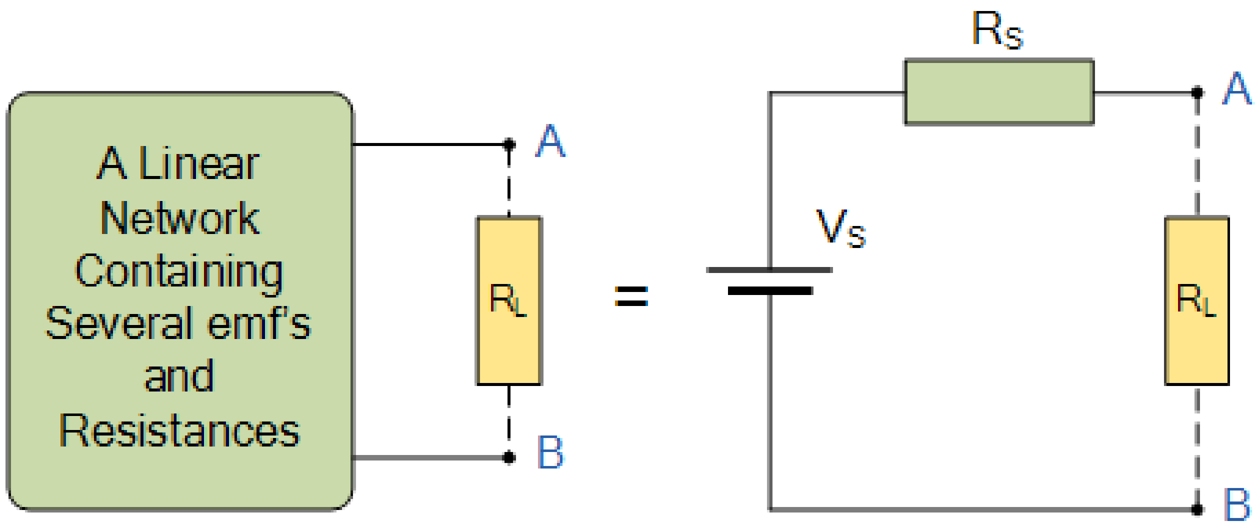


Kirchhoffs Voltage Law



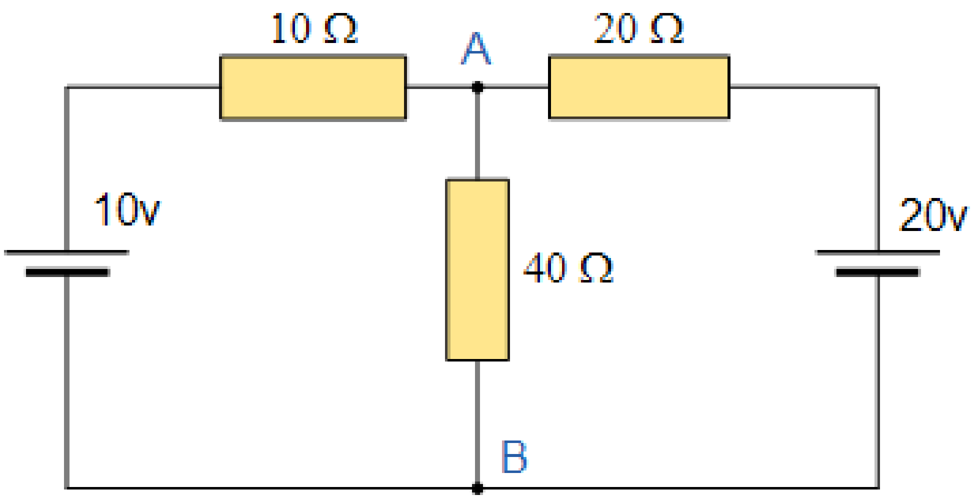
Thevenin’s theorem

Any linear circuit containing several voltage sources and impedances can be replaced by just one single voltage source in series with a single impedance connected across the load



Thevenin's theorem

Example: consider the following circuit. Find out the voltage across the load resistance (40Ω) using Thevenin's theorem



Step1: The value of the equivalent resistance, R_s is found by calculating the total resistance looking back from the terminals A and B with all the voltage sources shorted. We then get the following circuit.

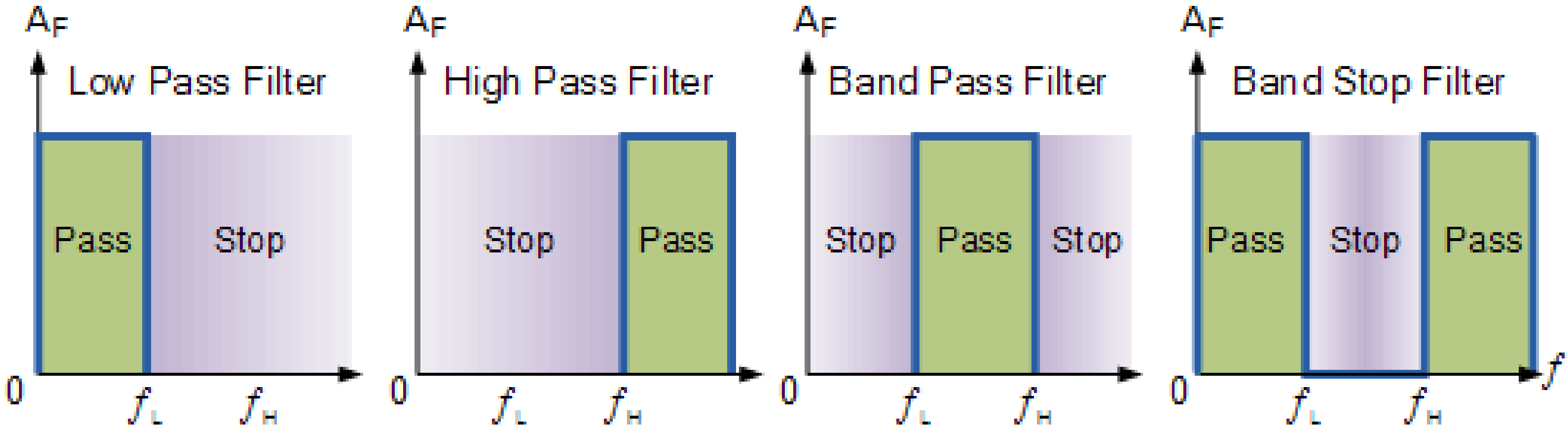
Step2: The value of the equivalent resistance, V_s can be found disconnecting the load resistance and calculating the open circuit voltage between AB.

Ans: 13.33V

R,L,C Filter circuits

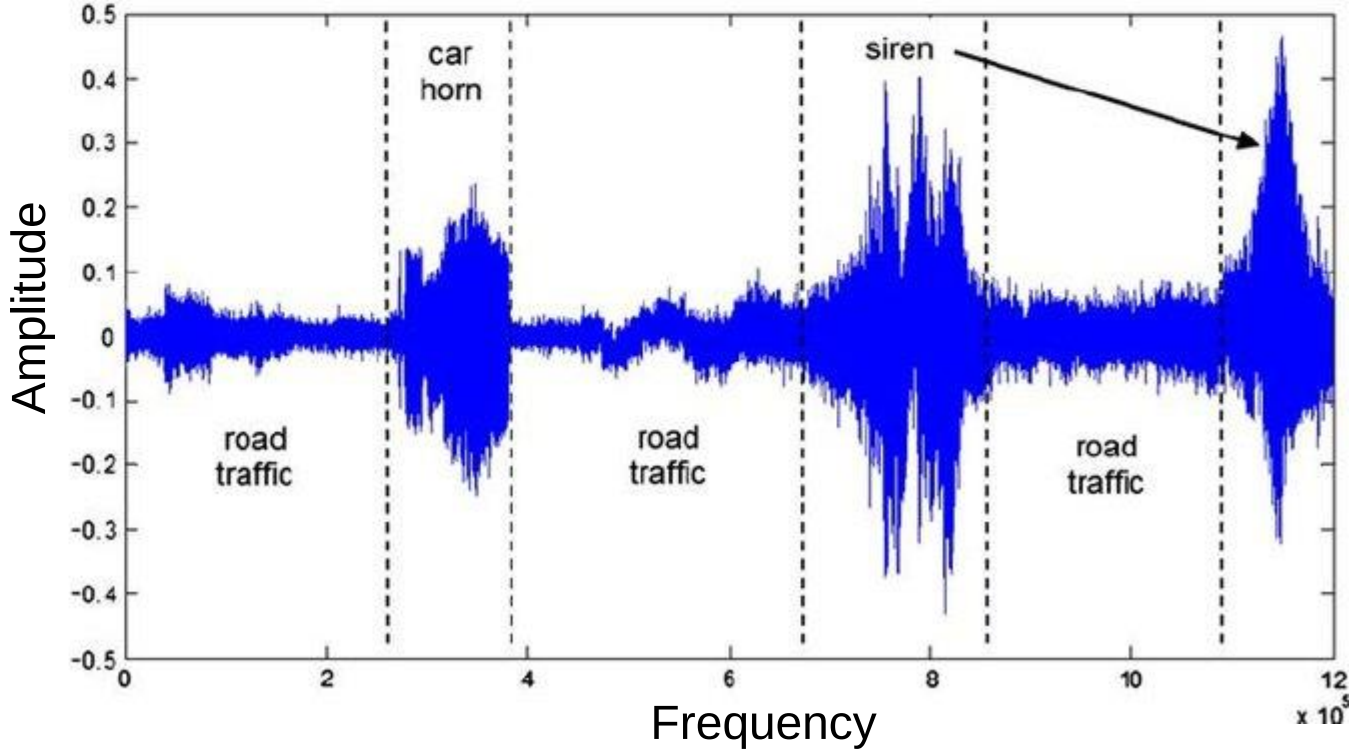
Filter circuits are used to remove unwanted frequency components (noise) from an input signal

Ideal filter response:



R,L,C Filter circuits

Example

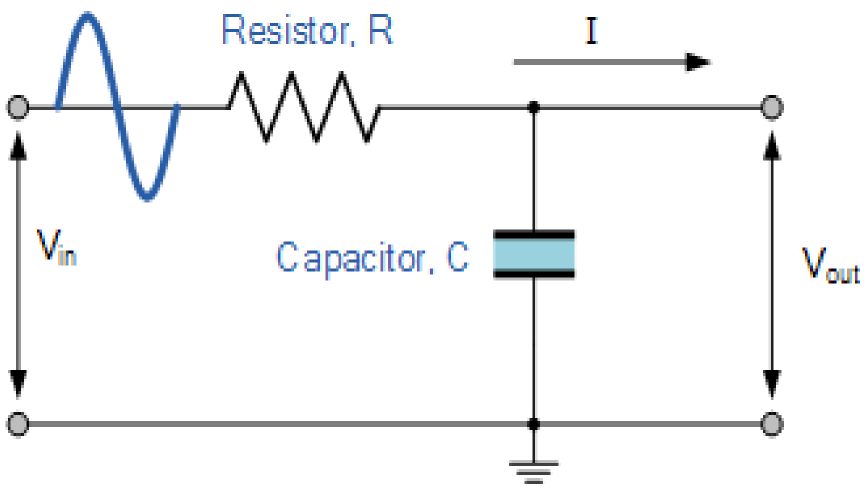


To retain only the sound of the siren from the audio signal we can use a high pass filter

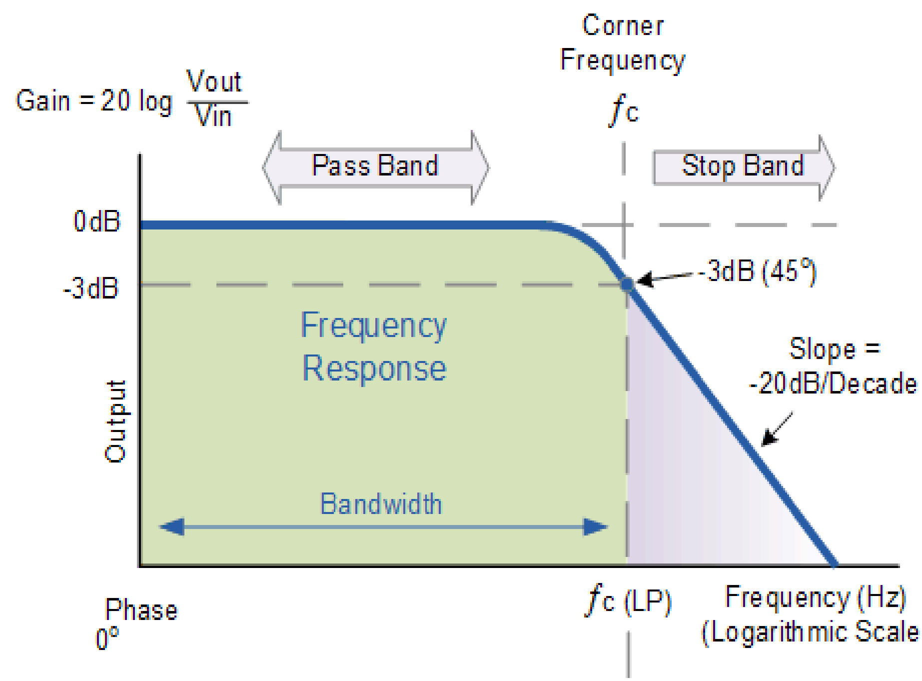
R,L,C Filter circuits

RC Circuit

Low pass filter: Blocks high frequency signals



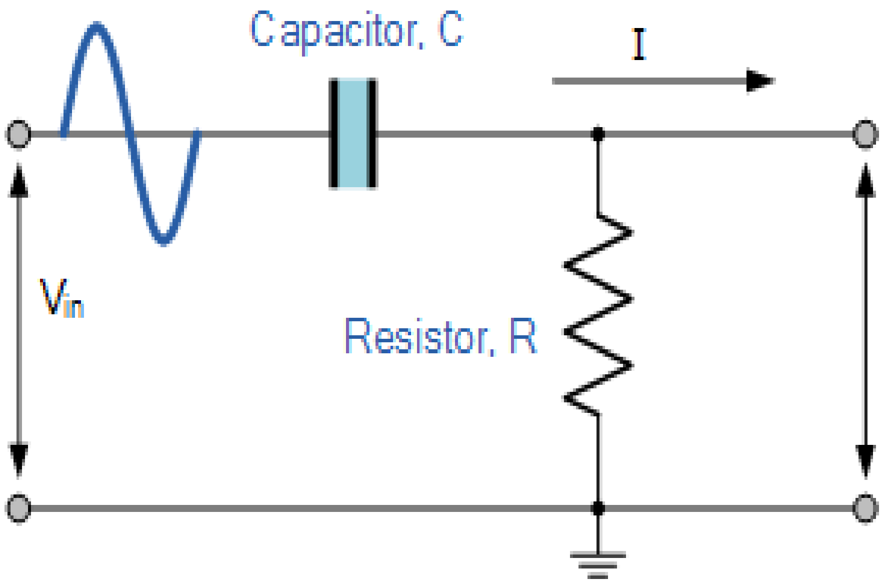
$$V_{out} = \frac{1}{j\omega RC + 1} V_{in}$$



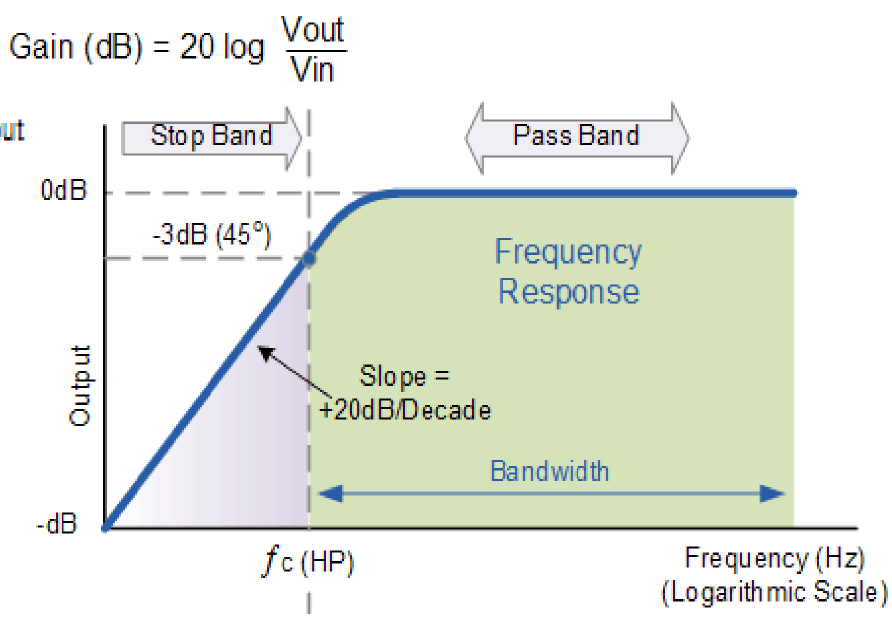
R,L,C Filter circuits

RC Circuit

High pass filter: Blocks low frequency signals

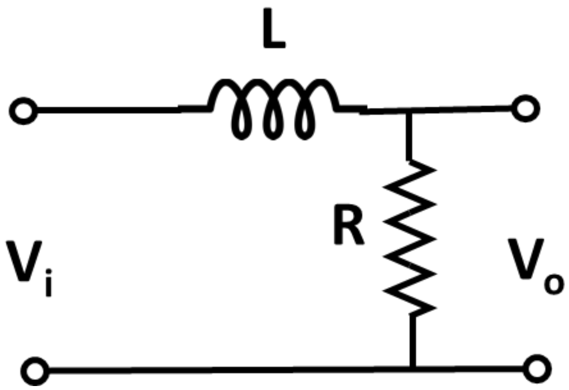


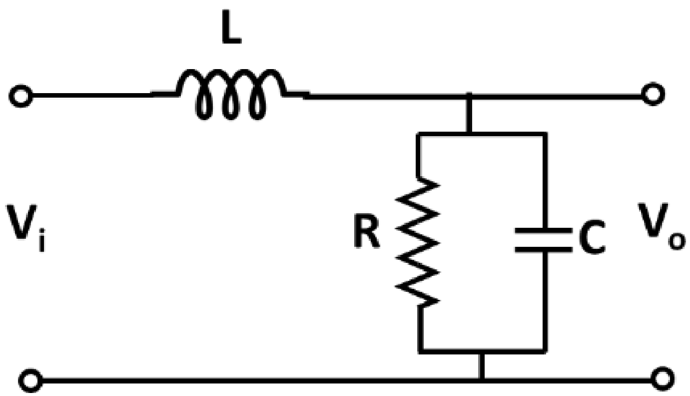
$$V_{out} = \frac{j\omega RC}{j\omega RC + 1} V_{in}$$

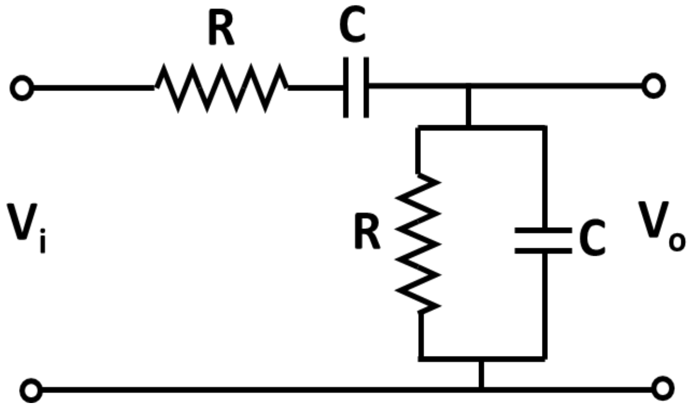


R,L,C Filter circuits

Exercise: What type of filters are the following circuits

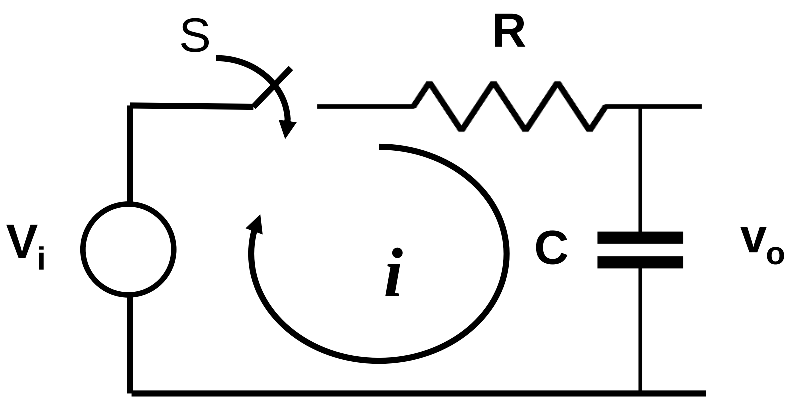






Transient Response of an RC circuits

Consider V_i is a DC voltage source connected in series with a resistance R and a capacitance C through a switch. If at time t=0, the switch is closed, then what would be the voltage across the capacitor and the current through it?

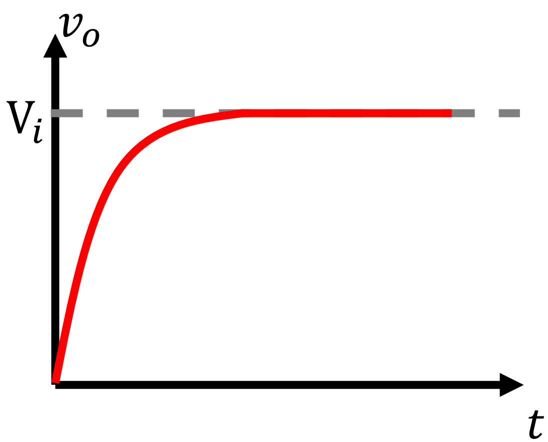


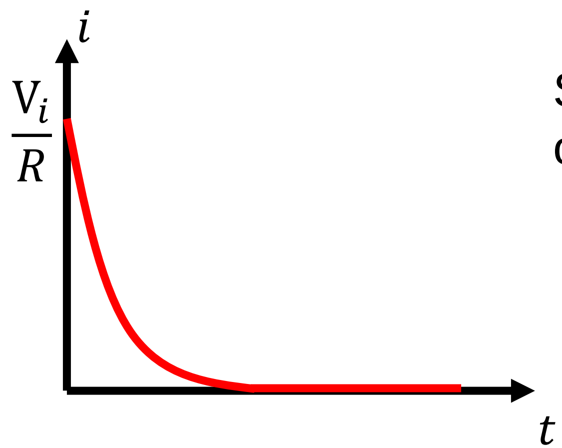
Current through C:

$$i(t) = C\frac{dv_o}{dt}$$

Using KVL in the circuit:

$$V_i = v_R + v_o$$
$$\Rightarrow V_i = iR + v_o$$
$$\Rightarrow V_i = RC\frac{dv_o}{dt} + v_o$$





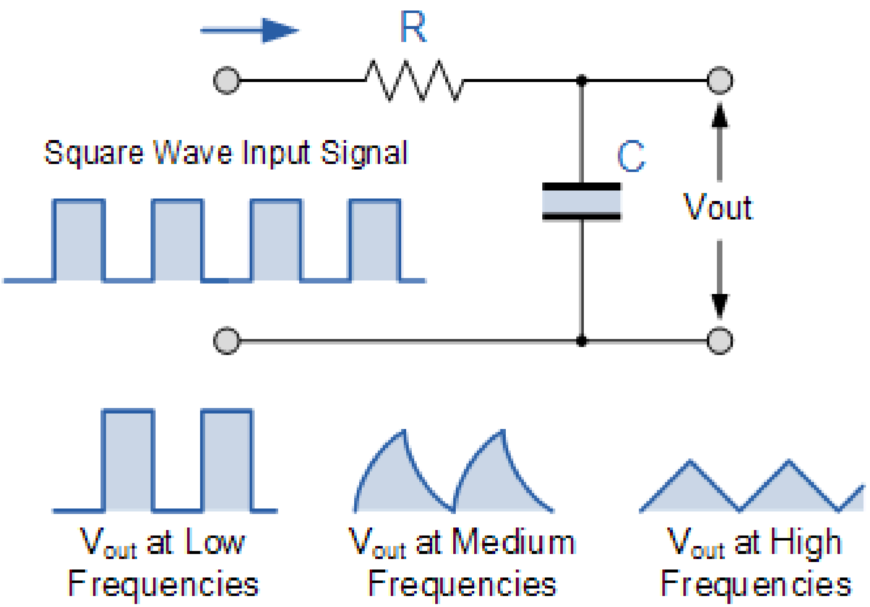
Solution to this non-homogeneous ordinary differential equation is

$$v_o = V_i(1 - e^{-t/RC})$$

$$i = \frac{V_i}{R}e^{-t/RC}$$

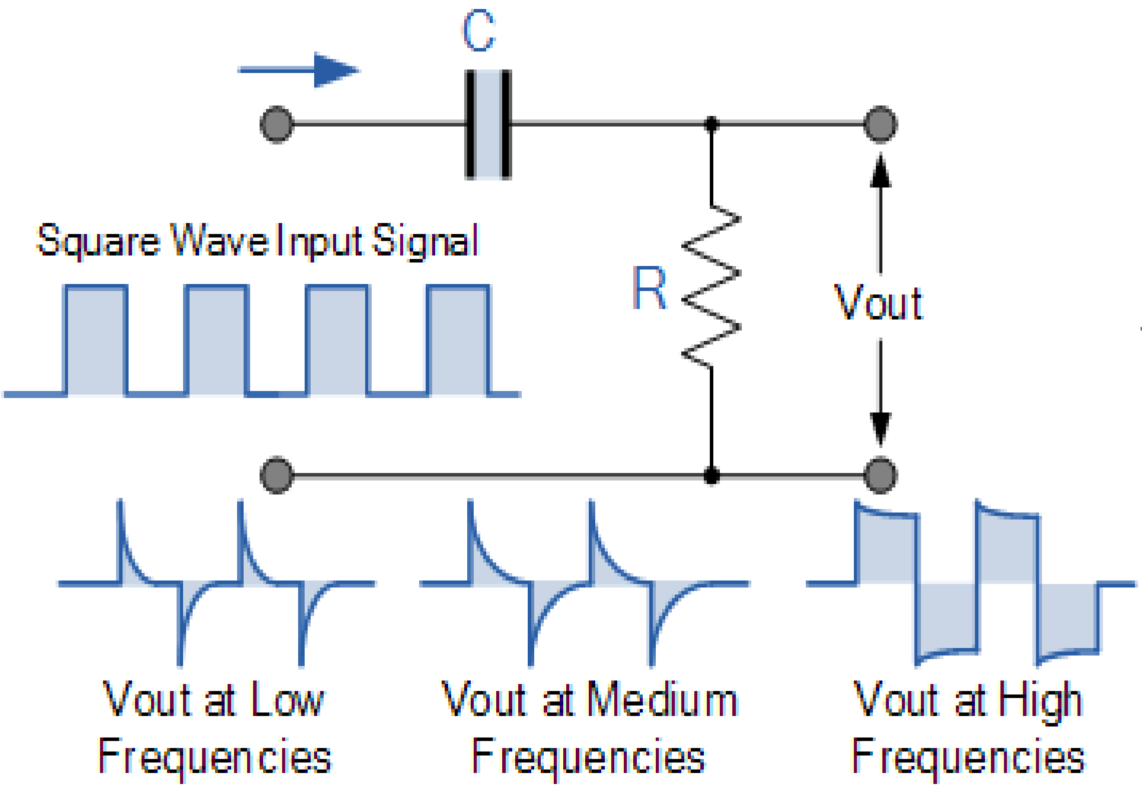
How does RC effect the response?

RC Circuit as integrator



$$V_{OUT} = \frac{1}{RC}\int_0^t V_{IN(t)}\,dt$$

RC Circuit as Differentiator



$$V_{OUT} = RC\frac{dV_{IN}}{dt}$$