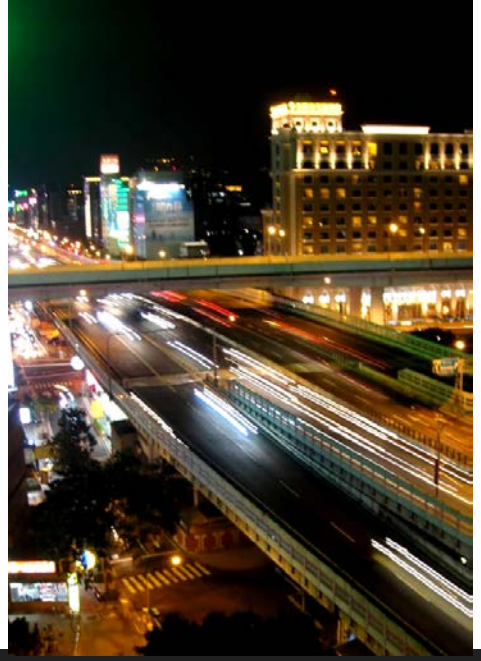
TAIPEI TECH

國立臺北科技大學



電路學 Circuit Theory

Lecture 0

An Overview of This Course

Week 1, Fall 2019

陳晏笙

Electronic Engineering, Taipei Tech

Information on Circuit Theory

Fall 2019 (Prof. Yen-Sheng Chen)

CIRCUIT THEORY

Office: CB-407-1 ext. 2281

E-mail: yschen@ntut.edu.tw

Office hours: Mon. 13:00−17:00

Main topics:

1. Basic concepts of circuit analysis
2. Advanced techniques for circuit analysis
3. Responses of RL, RC, and RLC Circuits
4. Sinusoidal steady-state analysis

Roadmap of Circuit Theory (1/2)

Simple resistive circuits (DC source)

Circuits with L or/and C (DC source)

AC circuits (Sinusoidal source)

Three-phase AC circuits

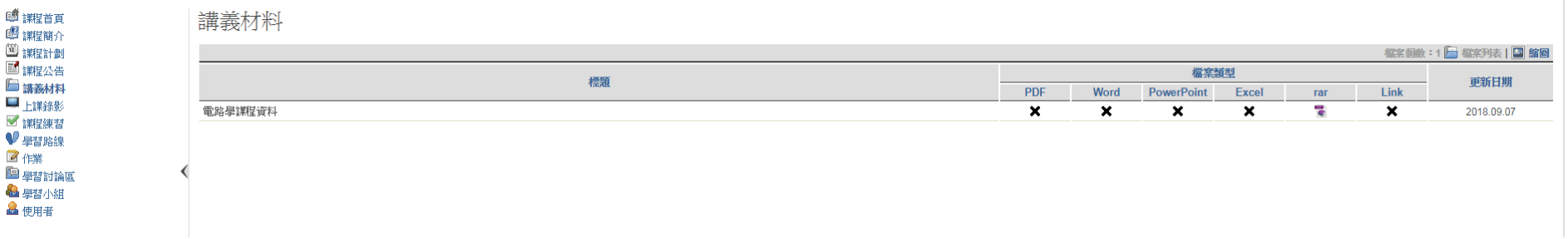
Treat a large circuit as two-port networks

Circuits with periodic sources

Use Laplace transform to solve ANY circuit

Texts (108-1)

1. Lecture notes available for download from 北科ｉ學園
2. James Nilsson and Susan Riedel, Electric Circuits: 10th Edition, Pearson
3. 陳在洸（編譯自上述課本第十版），電路學第十版，滄海書局



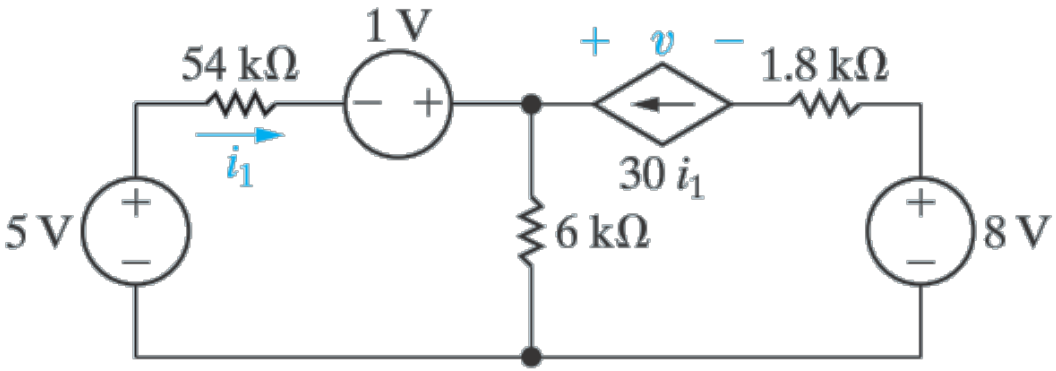
Grading (108-1)

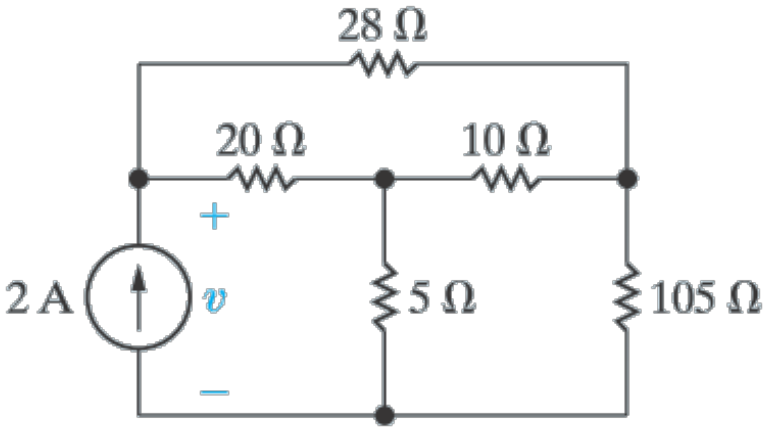
Midterm exam	50%
Final exam	50%

1. Cheating results in 0 grade and academic dishonesty charges
2. Sample questions from previous exams will be announced before the midterm and final exams
3. All grades final unless error in marking proven

Week	Topic	Detailed Lecture
1	Opening	Introduction to this course
2	(L1) Basic Concepts of Circuit Analysis	Circuit variables
3		2B method
4	(L2) Advanced Techniques for Circuit Analysis	Nodal analysis
5		Mesh analysis
6		Superposition theorems
7		Thevenin's theorem
8	(L3) Responses of RL, RC, and RLC Circuits	Capacitance and inductance
9		期中考
10		Natural responses of RC and RL circuits
11		Step responses of RC and RL circuits
12		Natural responses of RLC circuits
13		Step responses of RLC circuits
14	(L4) Sinusoidal Steady-State Analysis	Phasor analysis
15		Circuit analysis by the phasor approach
16		Circuit analysis by the phasor approach
17		Sinusoidal steady-state power calculations
18		期末考

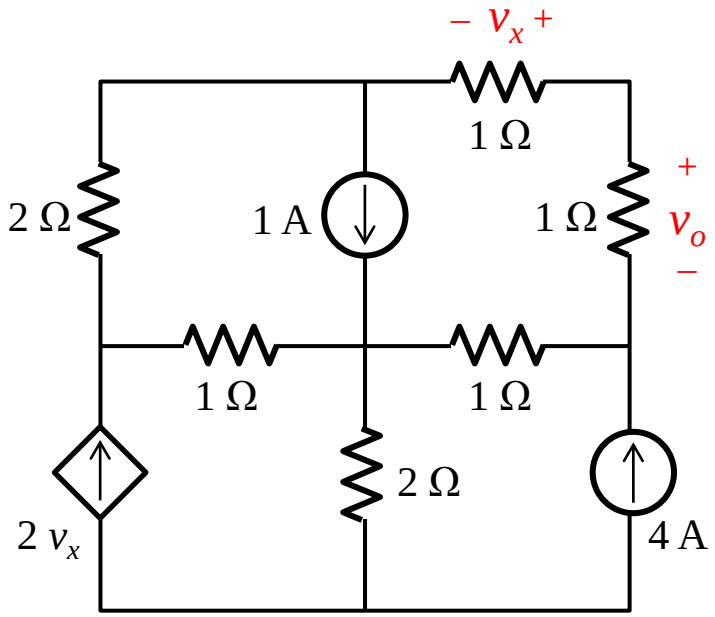
Basic Concepts of Circuit Analysis





1. The circuit variable: voltage, current, and power
2. The circuit element: active elements (especially dependent sources) and passive elements
3. How to solve a circuit? KCL, KVL, and component models
4. How to apply these techniques to solve simple resistive circuits?

Advanced Techniques for Circuit Analysis



More complicated circuits…

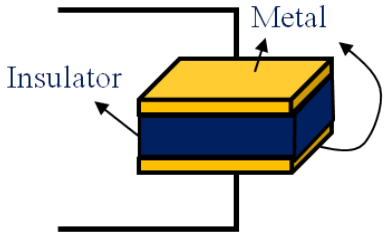
How to solve it?

We need more systematic methods!

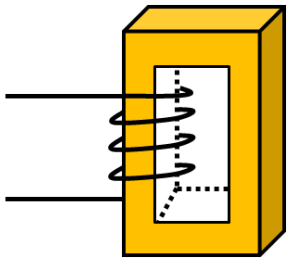
1. Node voltage analysis and mesh current analysis
2. How to summarize a large circuit by connecting smaller ones?

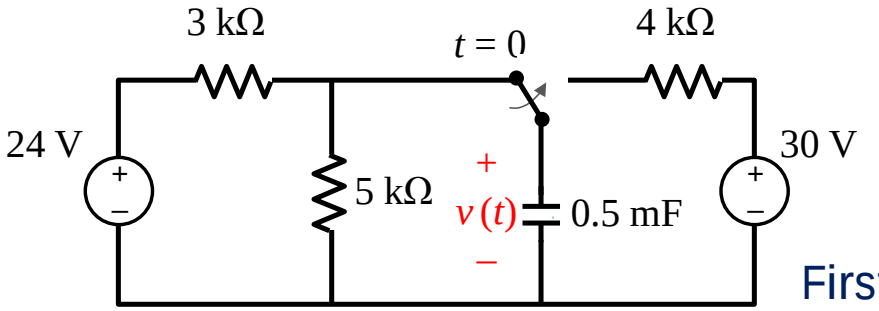
Responses of RL, RC, and RLC Circuits

Capacitor

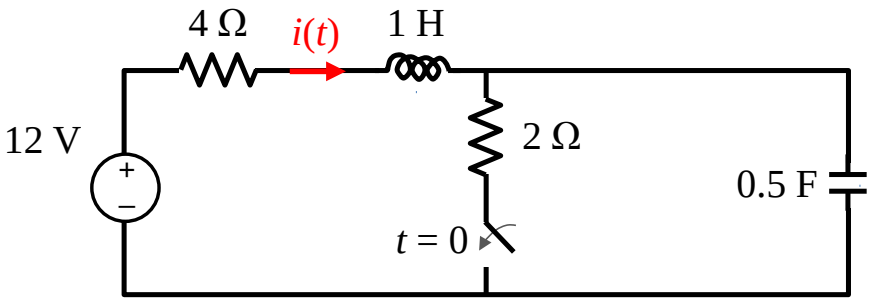


Inductor





First-order



Second-order

1. Now capacitors or inductors exist in your circuit
2. How to solve them? By solving differential equations
3. What's the difference between 1st and 2nd order DE?

Lecture 4

Sinusoidal Steady-State Analysis
(§4.1-§4.4)

Lecture 1-3

- We consider DC sources
- Transient solution + steady-state solution
- Such as:
  $v_S = 12$ V, $i_S = 200e^{-10t}$ mA

Lecture 4

- Now we deal with AC sources
- Steady-state solution
- Such as:
  $v_S = 2\cos(60t + 30°)$ V
  $i_S = I_m\cos(\omega t + \varphi)$ A

1. How to solve a circuit with AC sources?
2. If we'd like to know only the steady-state response, is there any more efficient method to handle it, instead of modeling differential equations?
3. How to calculate the power for AC circuits?
4. Does the AC power have physical meaning?

Information on Network Analysis

Spring 2020 (Prof. Yen-Sheng Chen)

NETWORK ANALYSIS

Office: CB-407-1 ext. 2281

E-mail: yschen@ntut.edu.tw

Office hours: Mon. 13:00−17:00

Main topics:

1. Sinusoidal steady-state analysis (balanced three-phase circuits)
2. Two-port network analysis
3. Laplace transform and its application in circuit analysis
4. Frequency selective circuits
5. Fourier series and its application in circuit analysis

Texts (108-2)

1. Lecture notes available for download from 北科ｉ學園
2. James Nilsson and Susan Riedel, Electric Circuits: 10th Edition, Pearson
3. 陳在洸（編譯自上述課本第十版），電路學第十版，滄海書局

Grading (108-2)

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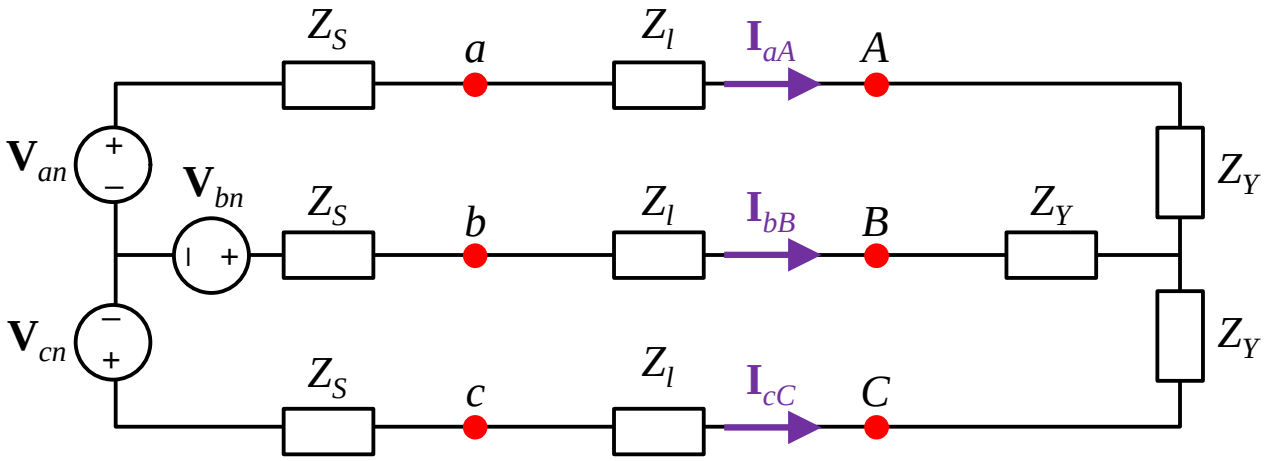
Week	Topic	Detailed Lecture
1	Opening	Introduction to this course
2	(L4) Sinusoidal Steady-State Analysis	Three-phase sources and three-phase loads
3		Analysis of Y-Y circuits and Y-Δ circuits
4	(L5) Two-Port Network Analysis	Two-port parameters
5		Computation of network parameters
6		Analysis of the terminated two-port circuit
7		春假停課一次
8		期中考
9	(L6) Laplace Transform and Its Application in Circuit Analysis	Review of Laplace transform
10		Circuit analysis in the *s* domain
11		Transfer functions
12		Steady-state sinusoidal analysis in the *s* domain
13	(L7) Frequency Selective Circuits	Introduction to frequency selective circuits
14		Low-pass filters and high-pass filters
15		Bandpass filters and bandreject filters
16	(L8) Fourier Series and Its Application in Circuit Analysis	Fourier series in circuit analysis
17		期末考

Rescheduling for Some Sessions

The following sessions are canceled:

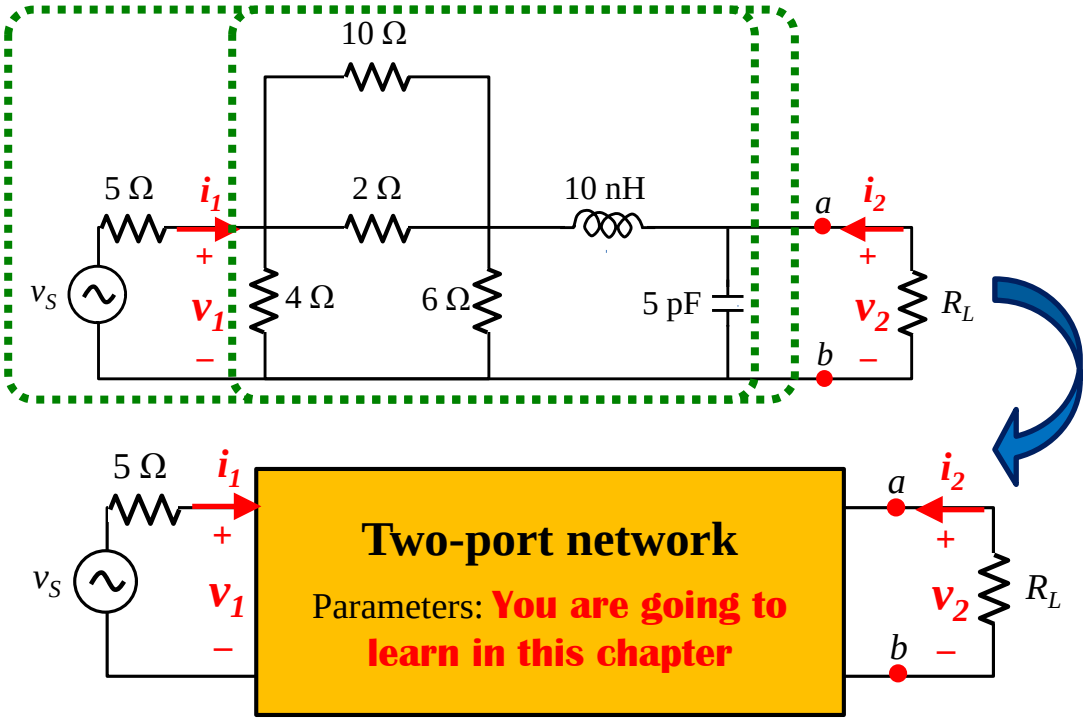
- 16, Oct., 2019 (WED)
- 20, Nov. 2019 (WED)

Sinusoidal Steady-State Analysis
(§4.5-§4.6)



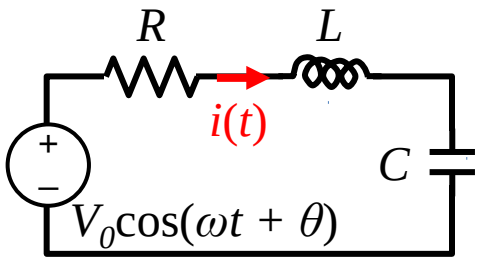
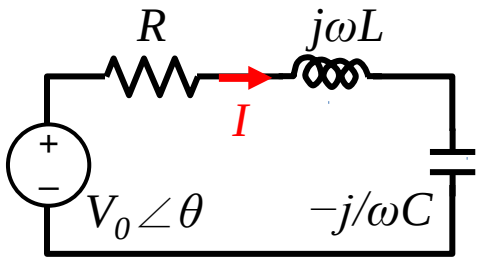
1. Why do we need three-phase circuits?
2. Understand the shortcut to calculate the voltage, current, power on these components
3. How do we calculate the response of a unbalanced three-phase circuit?

Two-Port Network Analysis



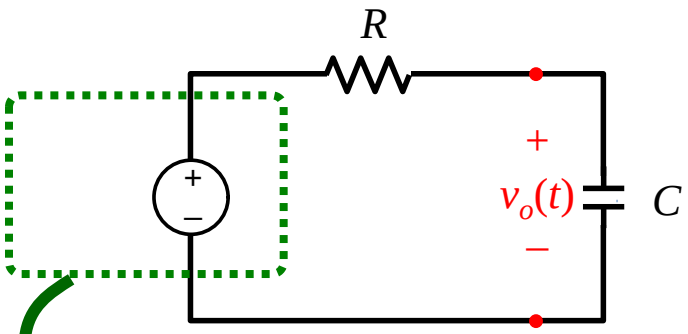
1. We have known how to summarize a large one-port circuit: Thévenin equivalent circuit
2. How do we summarize a large two-port circuit and apply new parameters to more practical situations?

Laplace Transform and Its Application in Circuit Analysis

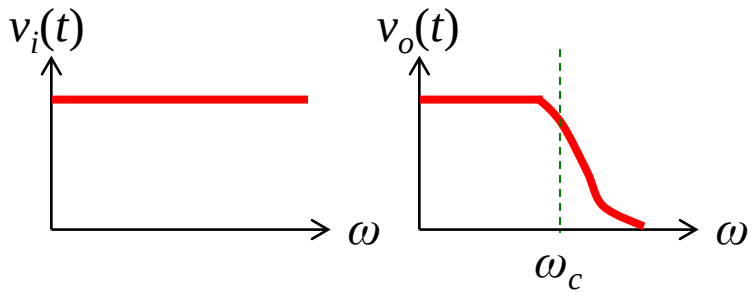
Time domain	Phasor domain	*s* domain (Laplace transform)
		Circuit diagram ?
$L\frac{d^2i(t)}{dt^2}+R\frac{di(t)}{dt}+\frac{1}{C}i(t)$ $=-\omega V_0\sin(\omega t+\theta)$	$\left[j\omega L+R+\left(-j\frac{1}{\omega C}\right)\right]I$ $=V_0\angle\theta$	Formulation ?
(Differential equation)	(Algebraic equation)	1. Arbitrary source 2. Complete solutions

➡ An important technique: transfer function

Frequency Selective Circuits

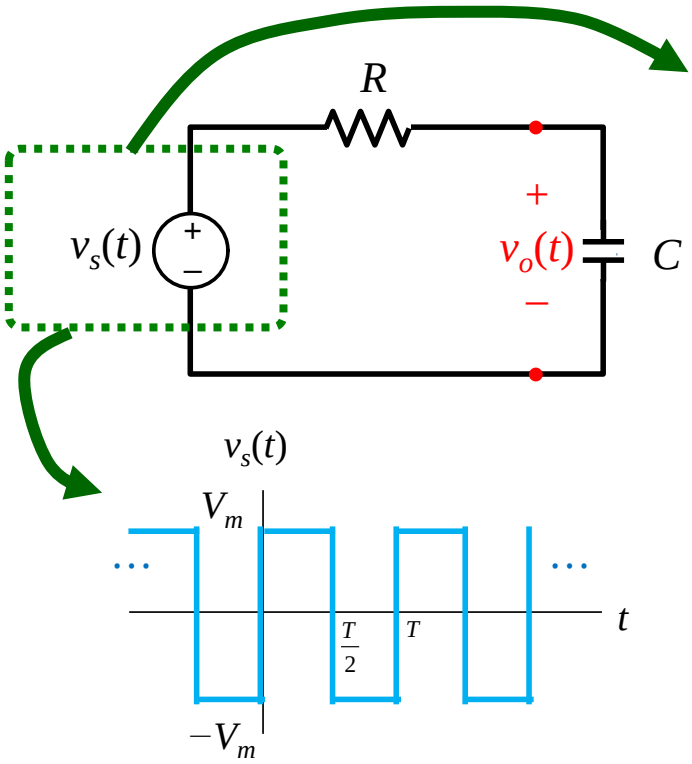


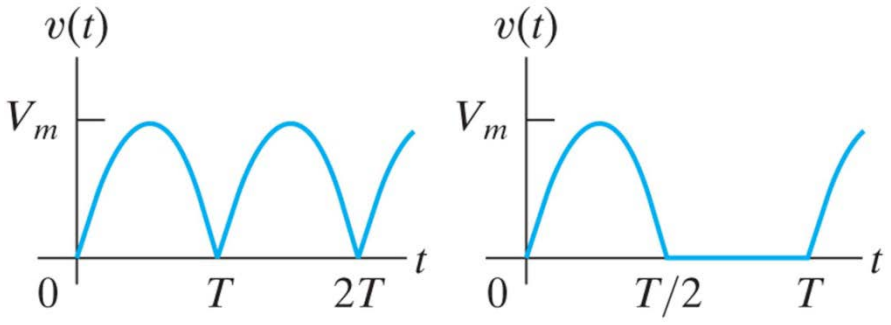
$$v_i(t) = V_0\cos(\omega t + \theta)$$



1. We have known how to analyze AC circuits, the source frequency of which is held constant
2. In this lecture, we analyze the effect of varying source frequency on circuit voltages and currents
3. We'll learn about 4 categories of frequency selective circuits:
   - Low-pass filters (RC/RL circuits)
   - High-pass filters (RC/RL circuits)
   - Bandpass filters (RLC circuits)
   - Bandreject filters (RLC circuits)

Fourier Series and Its Application in Circuit Analysis





Full-wave rectification Half-wave rectification

1. We have known how to treat dc sources and sinusoidal sources
2. How about square periodic sources? Triangular sources? Any arbitrary periodic sources?
3. How to calculate the voltage, current, power for these kinds of sources?