電子電工學

109學年度第一學期

郭致宏

國立成功大學

電機工程學系

2020年9月9日

課程名稱: **電子電工學**

上課班級: **化工系**

學 分 數: **3學分**

上課時間: 週三第**7~9 節**

上課教室: 化工系館 柏林講堂

教　師: 郭致宏 博士

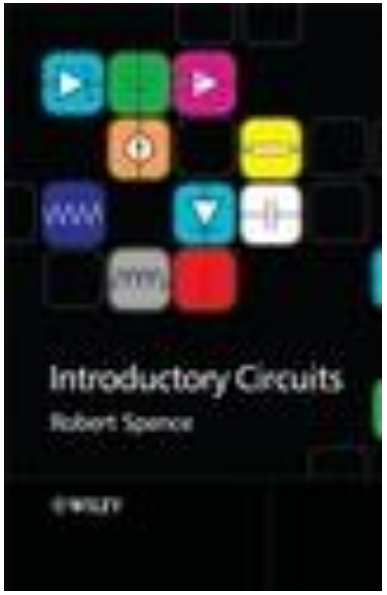
(電機系 VLSI/CAD組 副教授)

辦 公 室: 奇美樓 95511室(5樓)

Email: chkuo@ee.ncku.edu.tw

Office Hour:週三第2~4**節** (appointment by email)

助　教: 奇美樓 95515室(5樓)

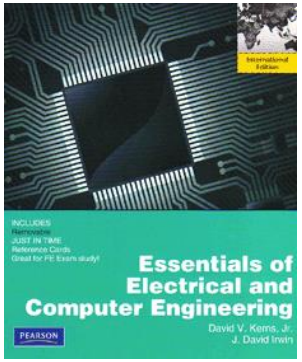


教材

課本:

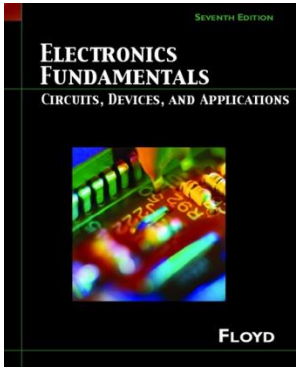
Introductory Circuits
Robert Spence,
John Wiley & Sons

http://onlinelibrary.wiley.com/book/10.1002/9780470694466



參考書:

ESSENTIALS OF ELECTRICAL AND COMPUTER ENGINEERING
KERNS & IRWIN,
Pearson Education



Electronics Fundamental, Circuit, Devices, and Applications
Thomas L. Floyd
Pearson Education

國立成功大學圖書館電子資源服務要點

五、 使用電子資源時應遵守著作權法及相關電子資源使用規範，限於個人學術研究或教學目的使用，嚴禁下列行為：

1、利用任何方式進行連續、大量、有系統地下載檔案或列印資料。

2、未經著作權人之同意將受保護之著作上傳於公開之網站上。

3、帳號借予他人或冒用他人帳號使用電子資源。

4、從事商業行為或架設違法網站供公眾下載受保護之著作。

5、其他涉及侵害智慧財產權之行為。

6、從事非教學研究等相關之活動或違法行為。

Grading Policy

Mid-term 1 ~20%

Mid-term 2 ~20%

Final Exam ~25%

Quiz/HW/Participation ~35%

Honor Codes

- Student ID Card required in any quiz or exam
- No cheating allowed in any quiz or exam
- Cheating will lead to ZERO term score
- Student Regulation will be enforced

國立成功大學學生獎懲要點

八、學生有下列情形之一者，予以**記小過**。

（六）違反考試規則或學術倫理，情節輕微者。

九、學生有下列情形之一者，予以**記大過或定期察看**。

（七）違反考試規則或學術倫理，情節較重者。

十、學生有下列情形之一者，予以**記定期察看**。

（一）違反考試規則或學術倫理，情節重大者。

（二）竄改成績或學籍等相關資料，情節較重者。

十一、學生有下列情形之一者，予以**退學**。

（一）違反考試規則或學術倫理，情節重大，無悛悔實據或連續違反者。

（二）竄改成績或學籍等相關資料，情節重大者。

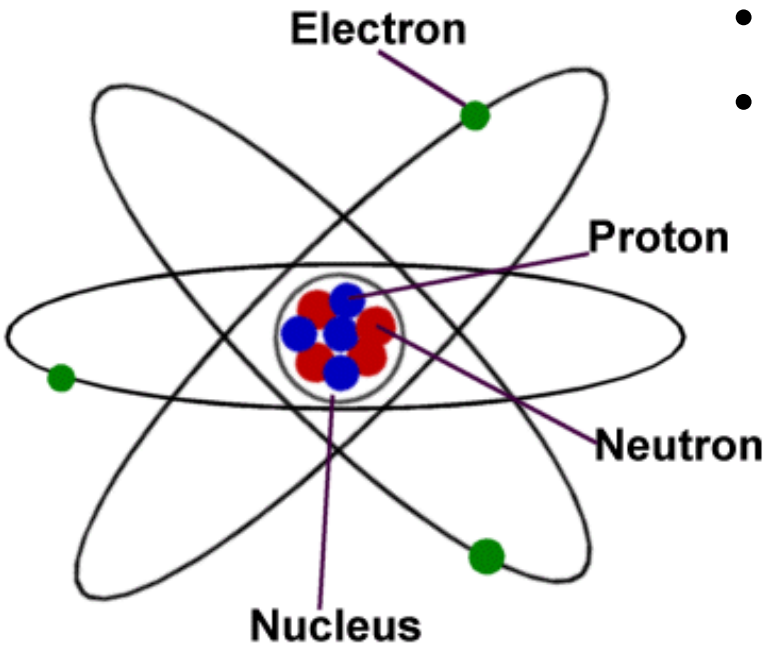
十二、學生有下列情形之一者，予以**開除學籍**。

（一）連續違反考試規則或學術倫理，且情節極為嚴重者。

106年12月20日106學年度第2次校務會議修正通過
107年2月7日教育部臺教學(二)字第1070010047號函

Electromagnetic Force

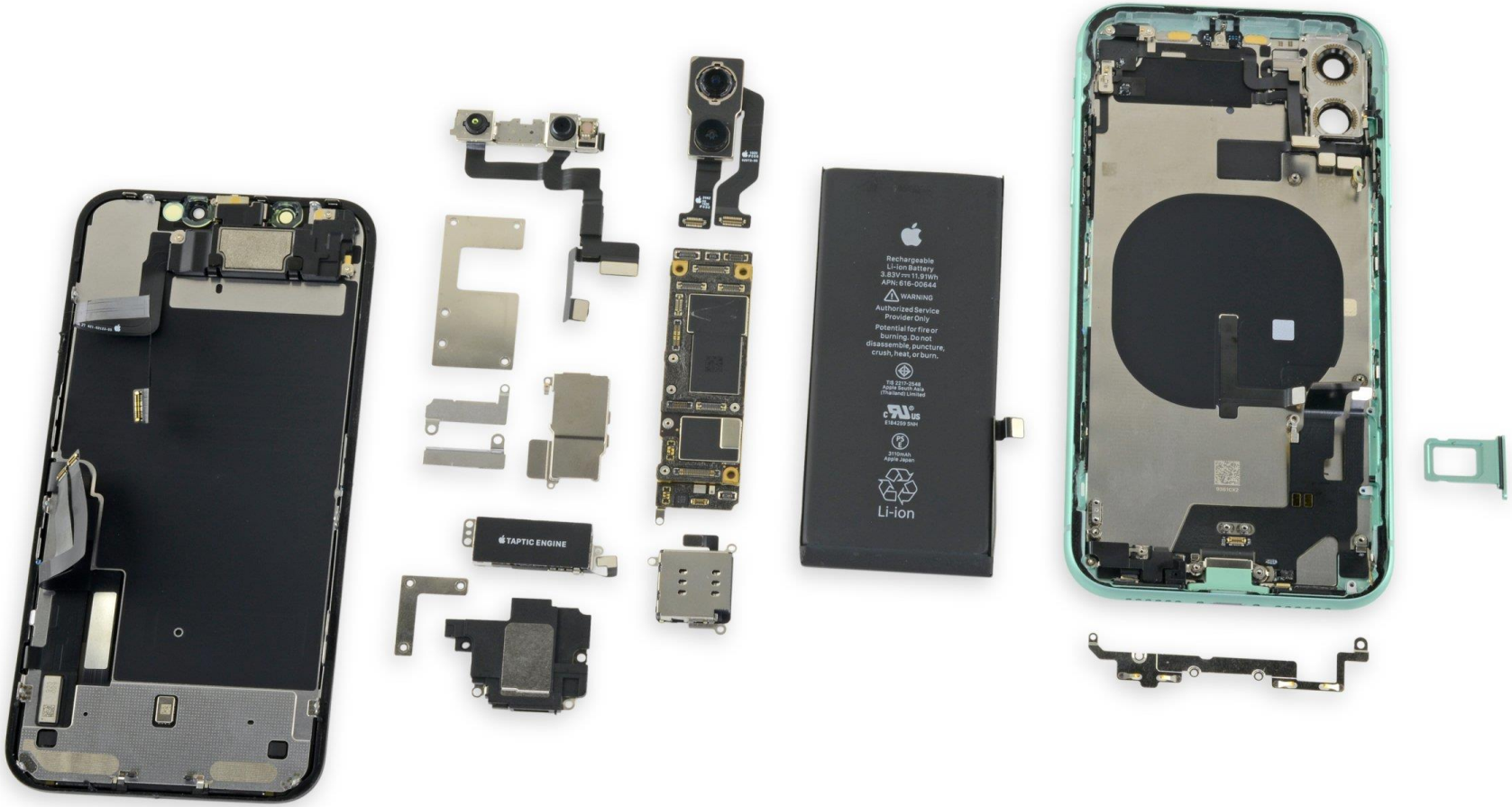
- Four basic forces in physics
- Most everyday phenomena can be explained using the laws of electromagnetism and gravity



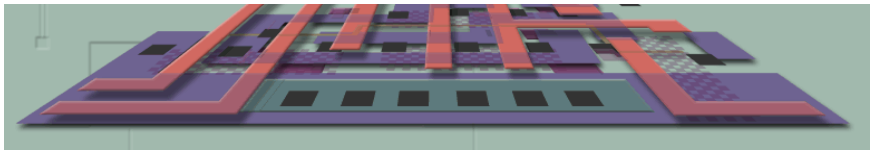
- Matter is mainly empty space
- Illusion of solid things
  - Clouds of electrons repel and prevent the atoms from passing through each other, even though they are largely empty space

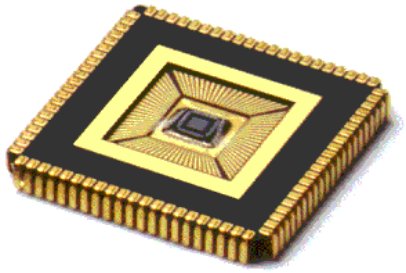
Modern Electric Circuits

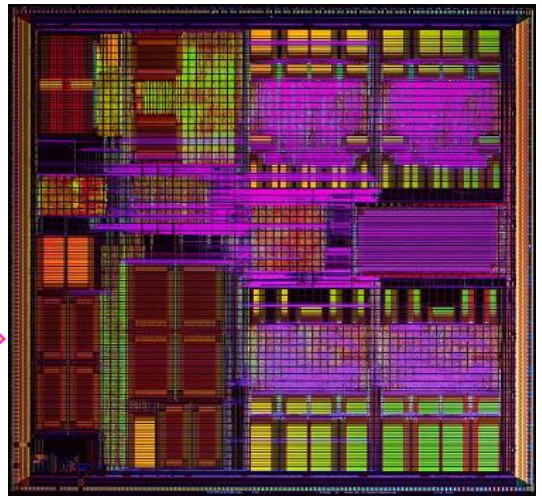
Inside iPhone 11



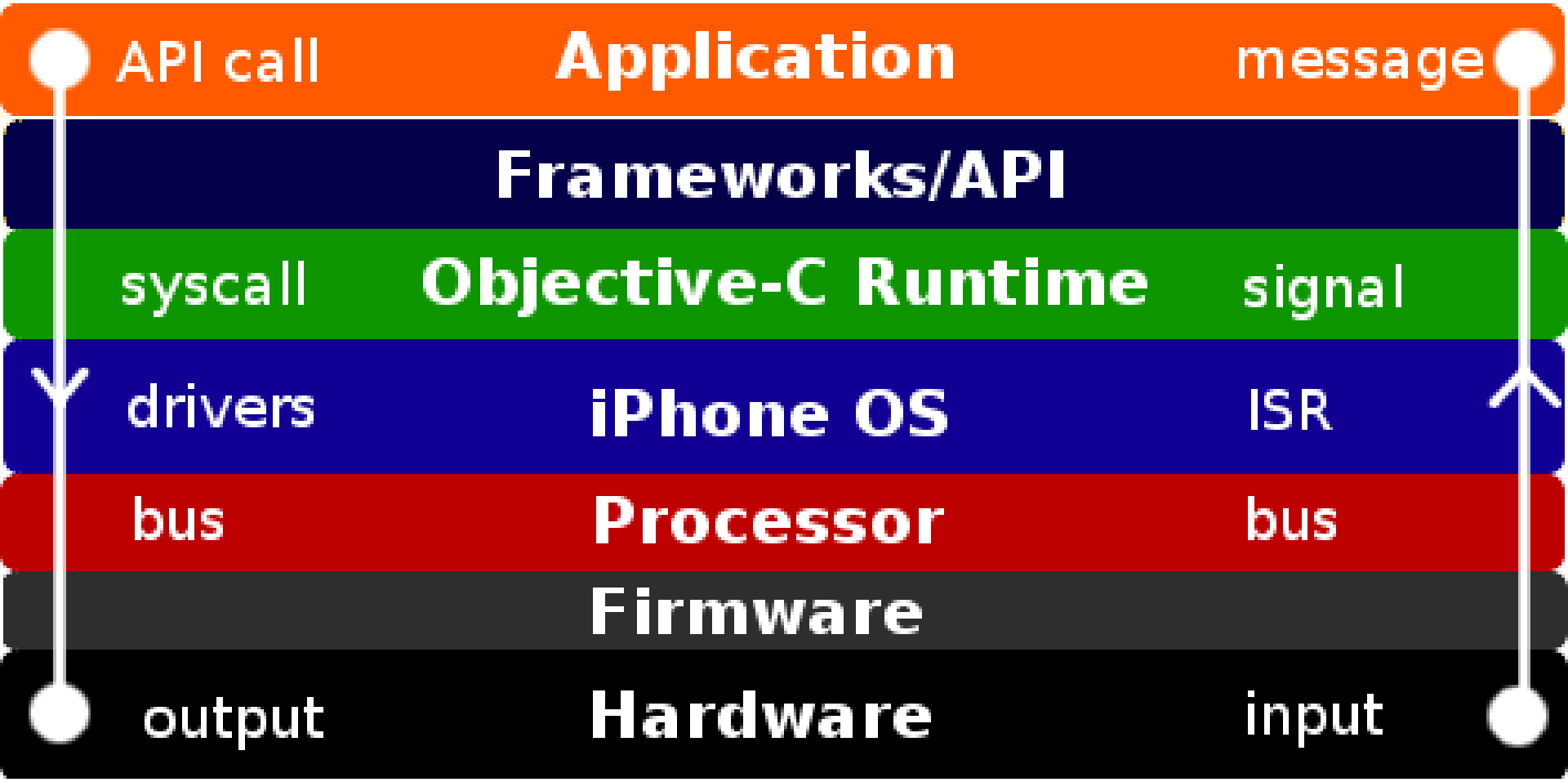
Integrated Circuits (IC)







iPhone Architecture



Electronic Systems:

PC, Wii, iPhone, iPad, Xbox, Nintendo, …

Analog Components: modulator, oscillator, A/D converter, RF amp…

Operating System

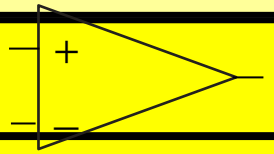
Program Language

Filters

Computer Arch.

OP Amp abstraction

Digital Abstraction



Amplifier

Circuits Abstraction

Physical Laws

Maxwell's, Schrödinger's,…

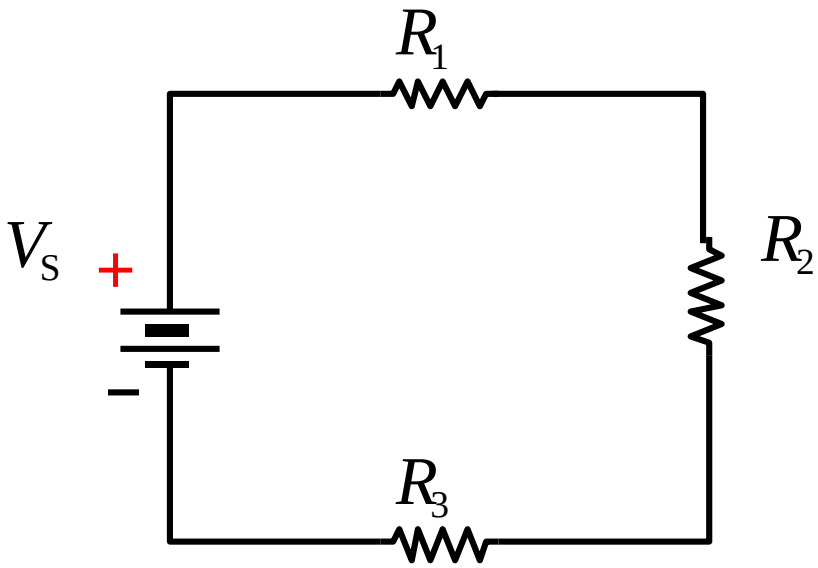
Natural Phenomena

TABLE 7–2
Maxwell's Equations

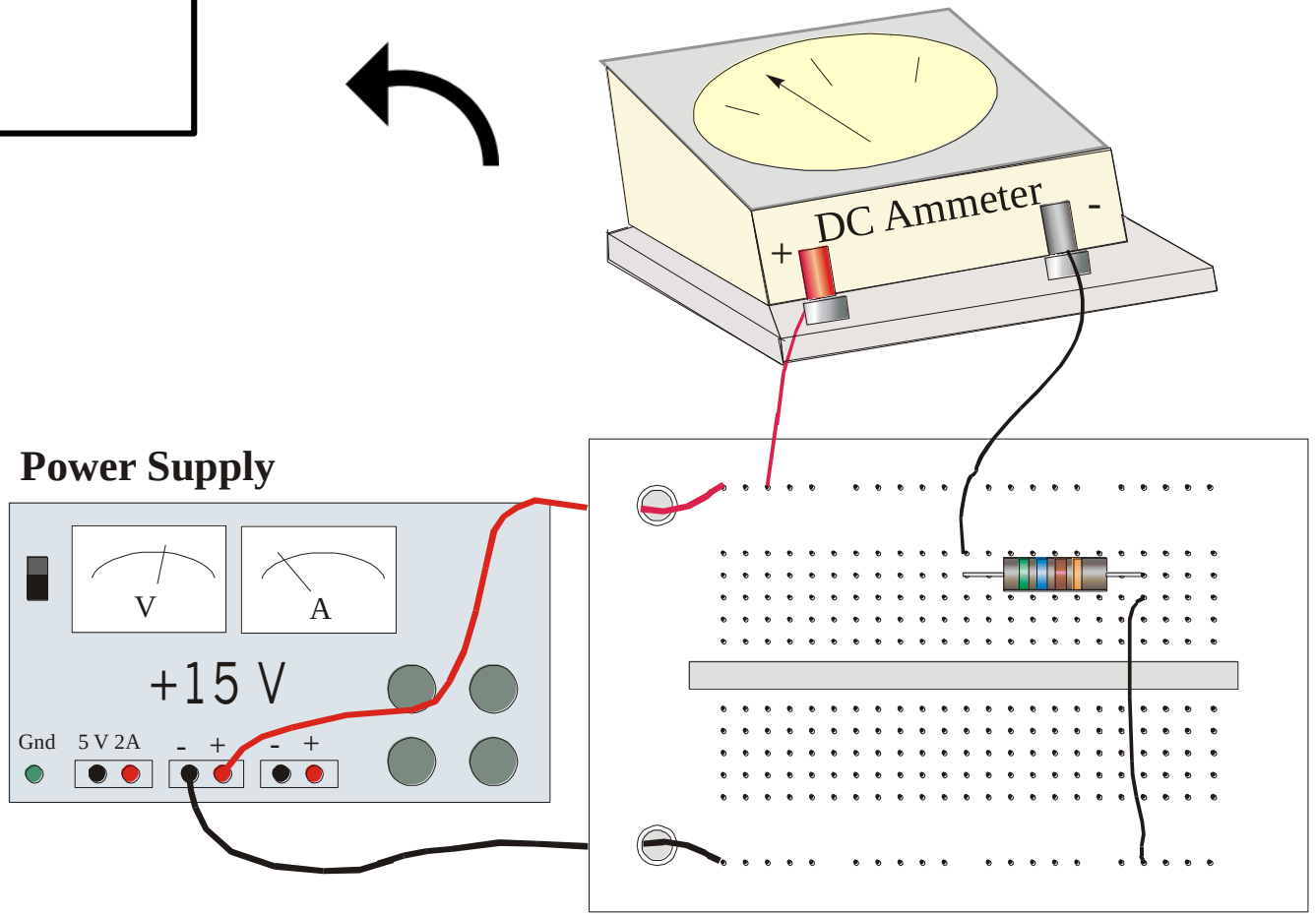
Differential Form	Integral Form	Significance
$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$	$\oint_C \mathbf{E} \cdot d\boldsymbol{\ell} = -\frac{d\Phi}{dt}$	Faraday's law
$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$	$\oint_C \mathbf{H} \cdot d\boldsymbol{\ell} = I + \int_S \frac{\partial \mathbf{D}}{\partial t} \cdot d\mathbf{s}$	Ampère's circuital law
$\nabla \cdot \mathbf{D} = \rho$	$\oint_S \mathbf{D} \cdot d\mathbf{s} = Q$	Gauss's law
$\nabla \cdot \mathbf{B} = 0$	$\oint_S \mathbf{B} \cdot d\mathbf{s} = 0$	No isolated magnetic charge

Schrödinger Equation:

$$i\hbar \frac{\partial}{\partial t} \Psi(\mathbf{r},t) = -\frac{\hbar^2}{2m} \nabla^2 \Psi(\mathbf{r},t) + V(\mathbf{r}) \Psi(\mathbf{r},t)$$



Simplify!



電子電工學
Class Outline

Part-I DC Circuits (直流電路)

Part-II OP amplifier (運算放大器)

Part-III AC Circuits (交流電路)

Part-IV Analysis of Change (變化分析)

Part-V Transistors (電晶體)

Prerequisites

- Calculus
  – single-variable
- General Physics
  – electricity

The Design Process

CHAPTER 1

Design Process

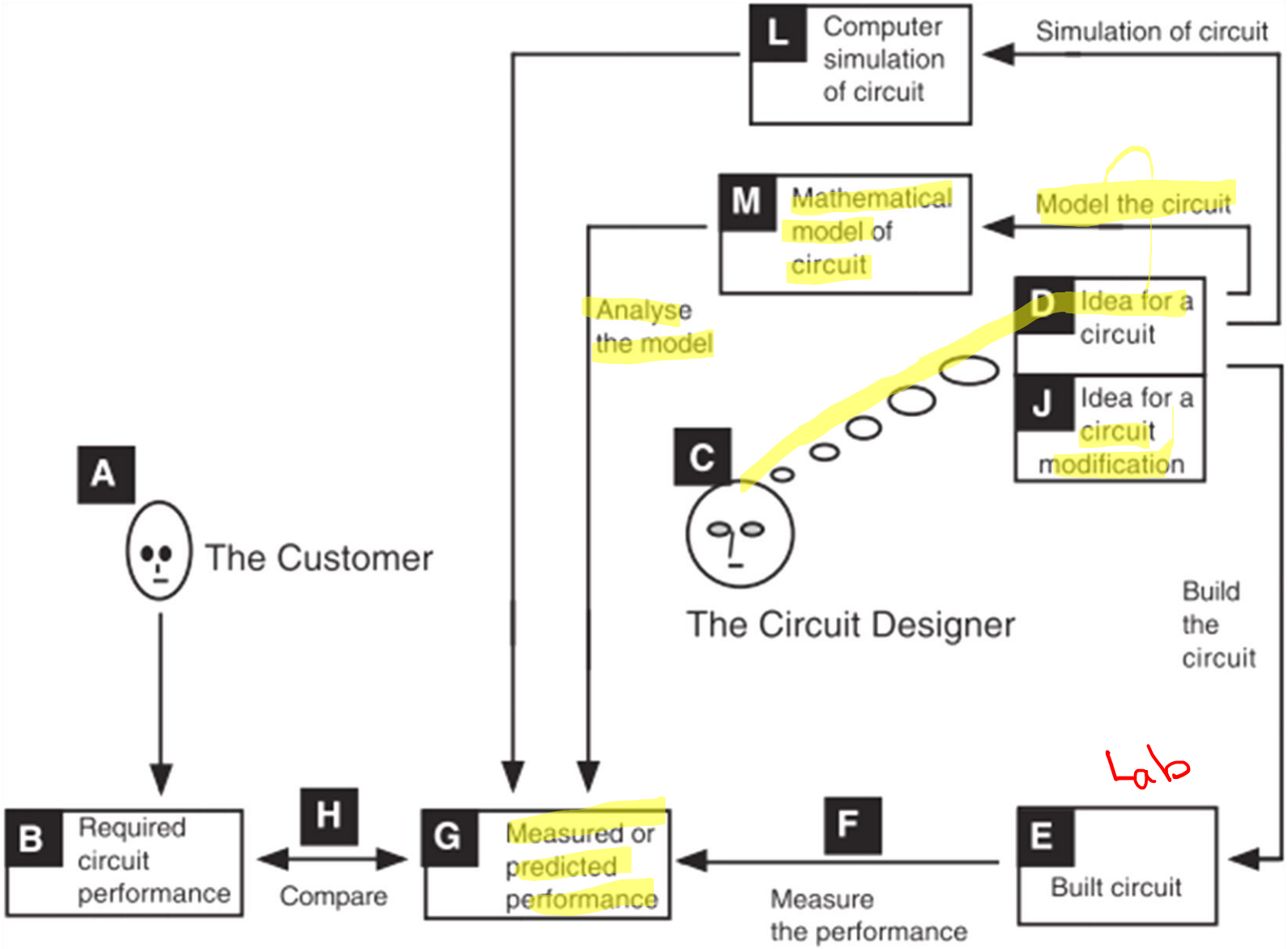
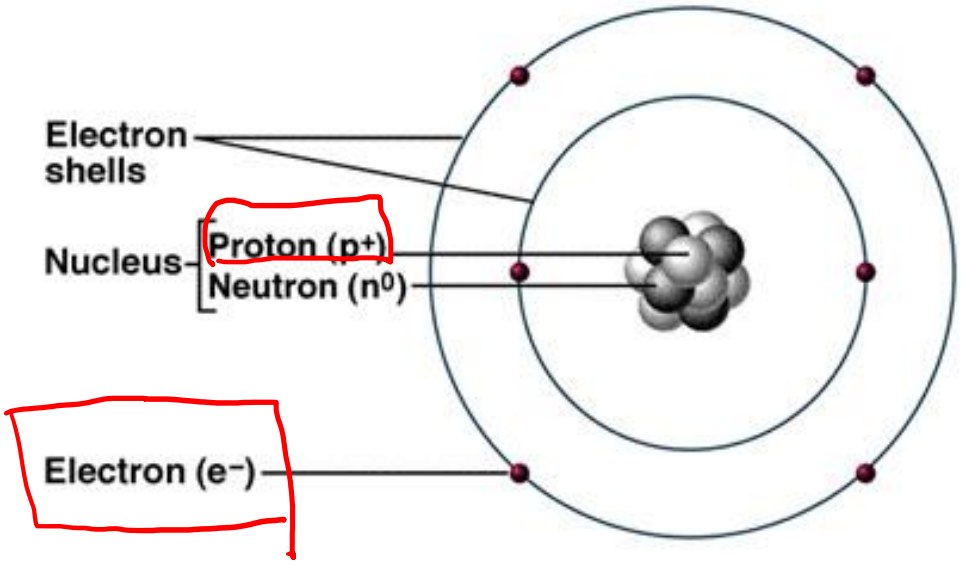


Figure 1.1 An overview of the process of circuit design

Electronic circuits

CHAPTER 2

Electronics: atom and electron



Negative Charge

Schrödinger Equation:

$$i\hbar \frac{\partial}{\partial t}\Psi(\mathbf{r},t) = -\frac{\hbar^2}{2m}\nabla^2\Psi(\mathbf{r},t) + V(\mathbf{r})\Psi(\mathbf{r},t)$$

electrical potential energy

Voltage,	Current,	Charge
V	I	Q
volt (v)	Ampere (A)	Coulomb
		$1C \cong 6.24 \times 10^{18}\ e^-$

$1J = 1V \times 1C$

1A : 1C electrons flowing through a certain pt per sec.

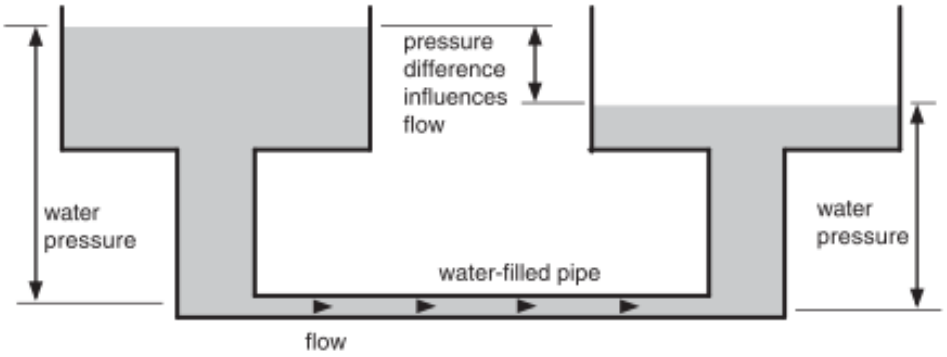


Figure 2.1 Illustrating the water pressure/flow analogy of voltage and current

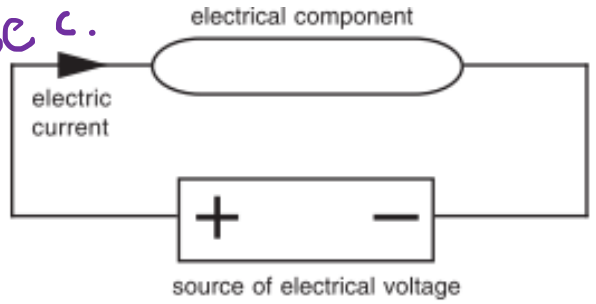
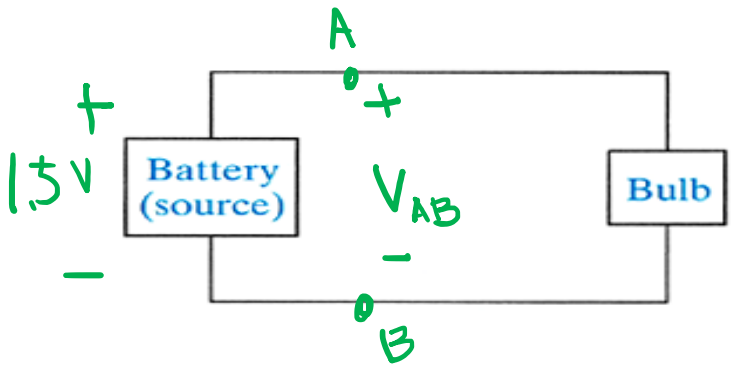


Figure 2.2 Application of a voltage across a component causes a current to flow

Voltage and current

$V = E / Q$

$1V = 1J / 1C$



Volt difference of electrical potential energy per unit of charge between 2 points

$I = Q / T$

$1A = 1C / 1 sec$

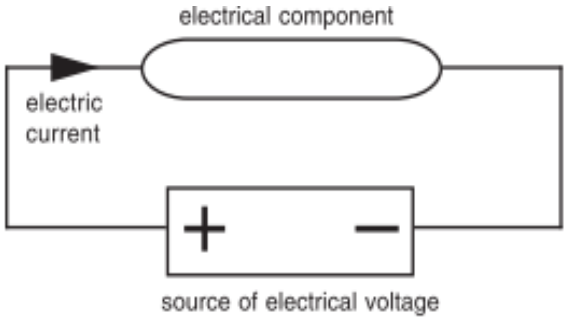


Figure 2.2 Application of a voltage across a component causes a current to flow

Ampere quantity of electrons flowing through a certain point per second

Voltage and current

Electric Current +I ⇒ Convention

Electron Current -I

V+ → V-

High → Low voltage voltage

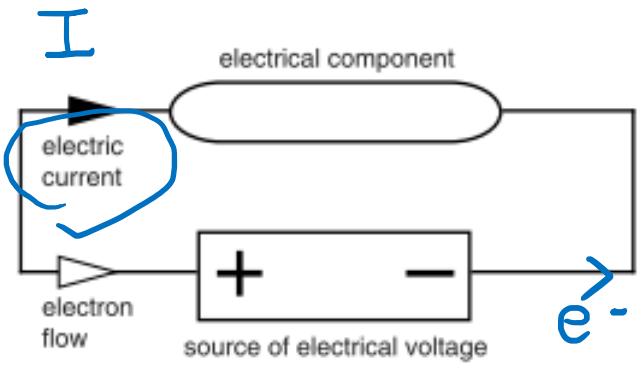


Figure 2.3 Negative free electrons are attracted to the positive potential of the source. However, in all discussions of electrical circuits the conventional current is regarded as flowing in the opposite direction

Voltage and current

multimeter

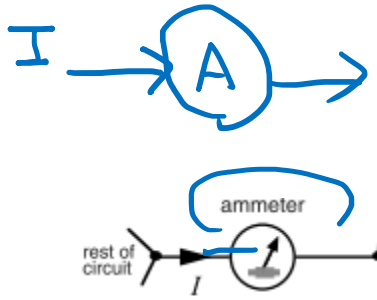


Figure 2.4 An ammeter indicates the value of the current *I* flowing through it

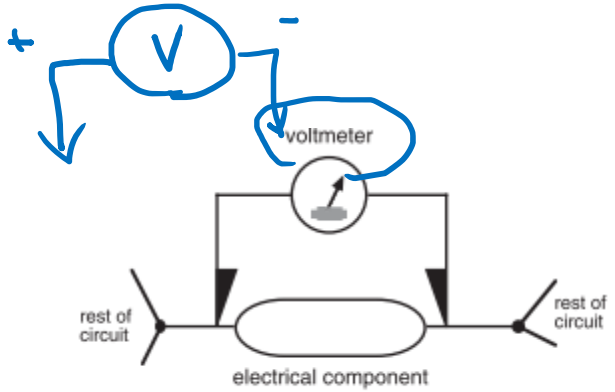
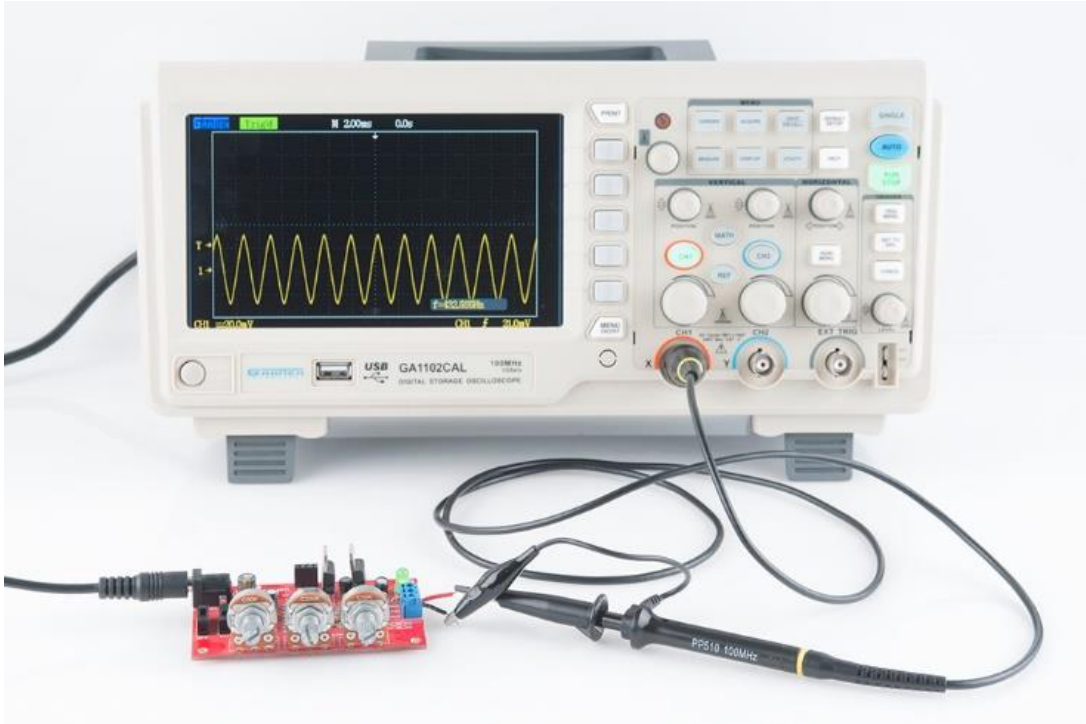


Figure 2.5 A voltmeter indicates the value of the voltage between two points in a circuit

Voltage and current

示波器

$v(t) \sim i(t)$



oscilloscope

Electrical components

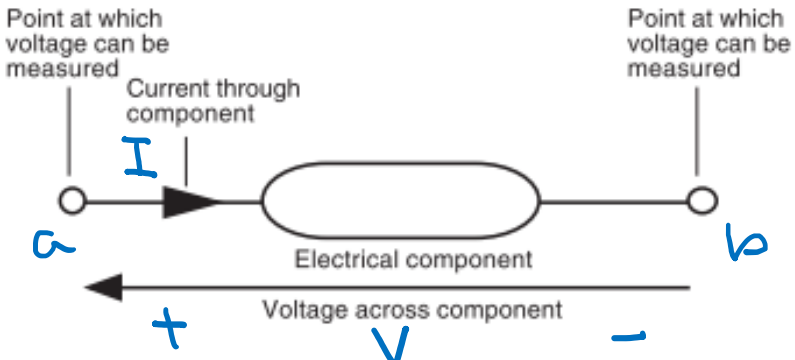
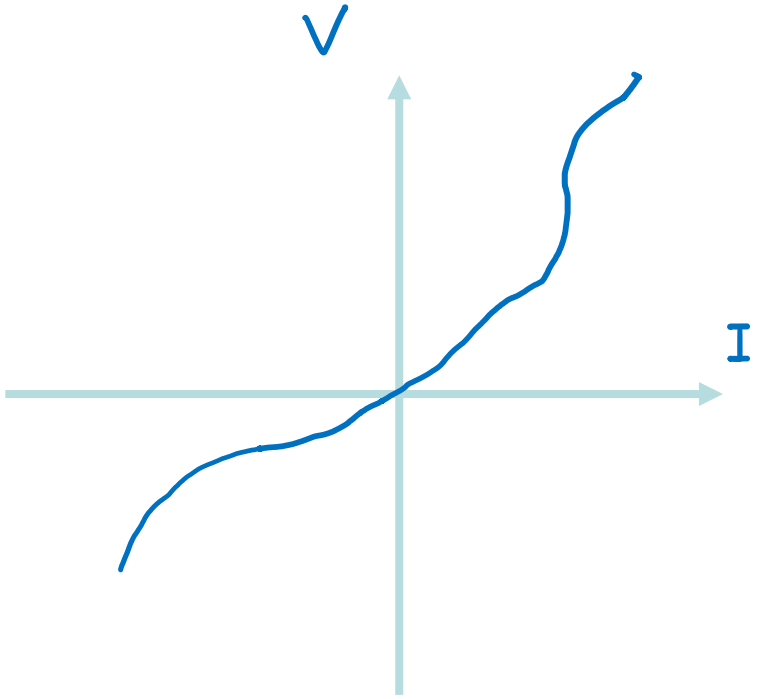


Figure 2.8 Conventional indication of current and voltage associated with an electrical component

$$V_{ab} = V_a - V_b$$



I-V characteristic

Electrical components

R : Resistor

L : Inductor

C : Capacitor

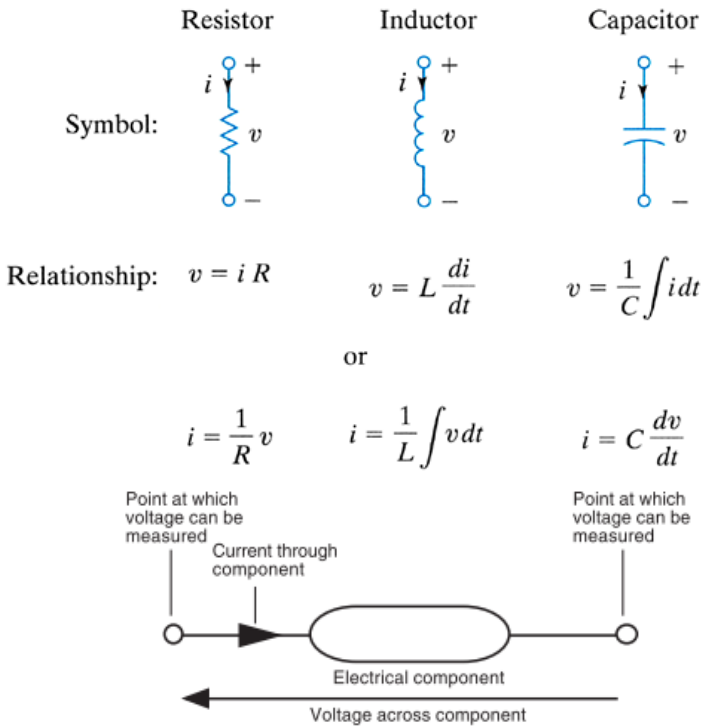
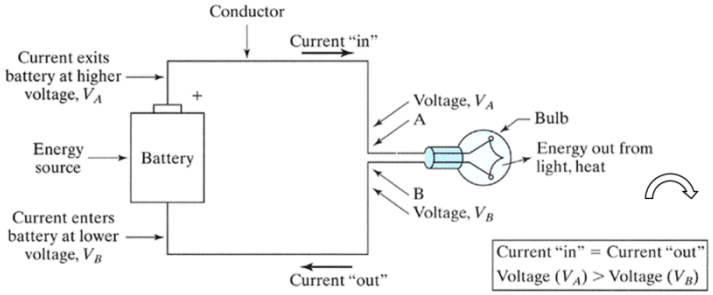
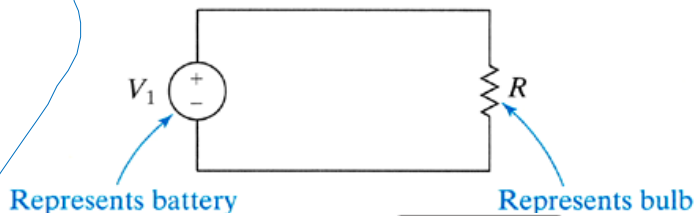


Figure 2.8 Conventional indication of current and voltage associated with an electrical component

Electrical components



Equivalent Circuit



I-V characteristic is the same

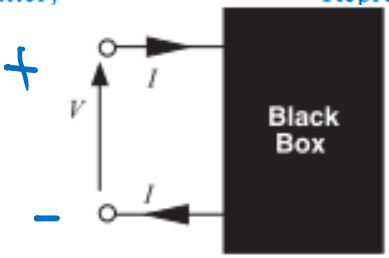


Figure 2.9 Relevant to a definition of the supply of energy to a two-terminal black box

Power: rate of electrical energy

$P = \Delta E / T = \frac{\Delta E}{Q} \cdot \frac{Q}{T}$

$P = VI$

$= V \cdot I$

Watt

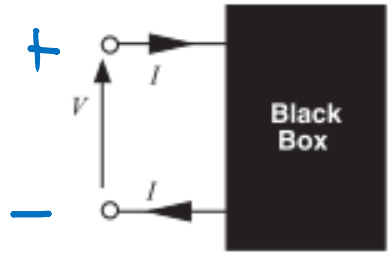
Joule/s

Volt

J/C

Amp

C/s



Power Rating 額定

Figure 2.9 Relevant to a definition of the supply of energy to a two-terminal black box

Circuit diagrams

Circuit

= Interconnection

of components

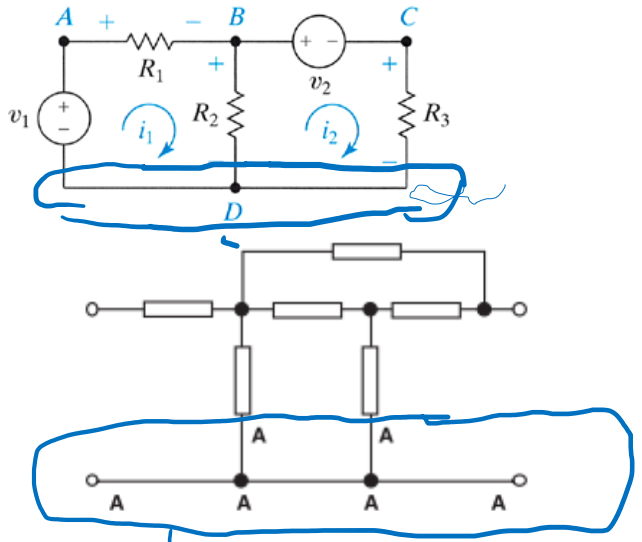


Figure 2.10 A circuit diagram shows how components are connected together. Every point (e.g., A) along a wire has the same voltage

Same voltage.

Summary – Electronic circuits

- Basic quantities
  - Charge
  - Voltage
  - Current
  - Power
- Electrical components
  - Resistor
  - Capacitor
  - Inductor
- Circuit diagrams
  - Interconnection of components