Circuits and System 1 - 2^{nd} Semester - Week 1

Dr. Salman Ahmed

April 7, 2021

Course Information

Course Title: Circuits and Systems 1

Course Code: CSE-103

Credit Hours Theory: 3hr

Credit Hours Lab: 1hr

Time Schedule:

- Lectures: Wednesdays and Thursdays

Primary Textbook: Richard Dorf and James Svoboda, *Introduction to Electric Circuits*, $\mathbf{9^{th}}$ Edition.

Reference Textbook: James Nilsson and Susan Riedel, *Electric Circuits*, $\mathbf{9^{th}}$ Edition.

Instructor Information

Instructor: Dr. Salman Ahmed, Assistant Professor

Qualification:

- PhD, University of Alberta, Canada (2013)
- MSc, Universiti Teknologi Petronas, Malaysia (2007)
- BSc in Computer Information Systems Engineering (Gold Medalist), UET Peshawar (2005)

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Circuit Terminologies

In an electric circuit, two terminologies are important

- Current: Flow of charges on electrons
- Voltage: Potential difference between two points

Conventional flow of current: from positive to negative

This convention was used by Benjamin Franklin and is commonly used in all textbooks (and practice)

Actually, current is generated when (negative) charges of electron flow

Circuit Terminologies

Circuit: Schematic having interconnection of elements

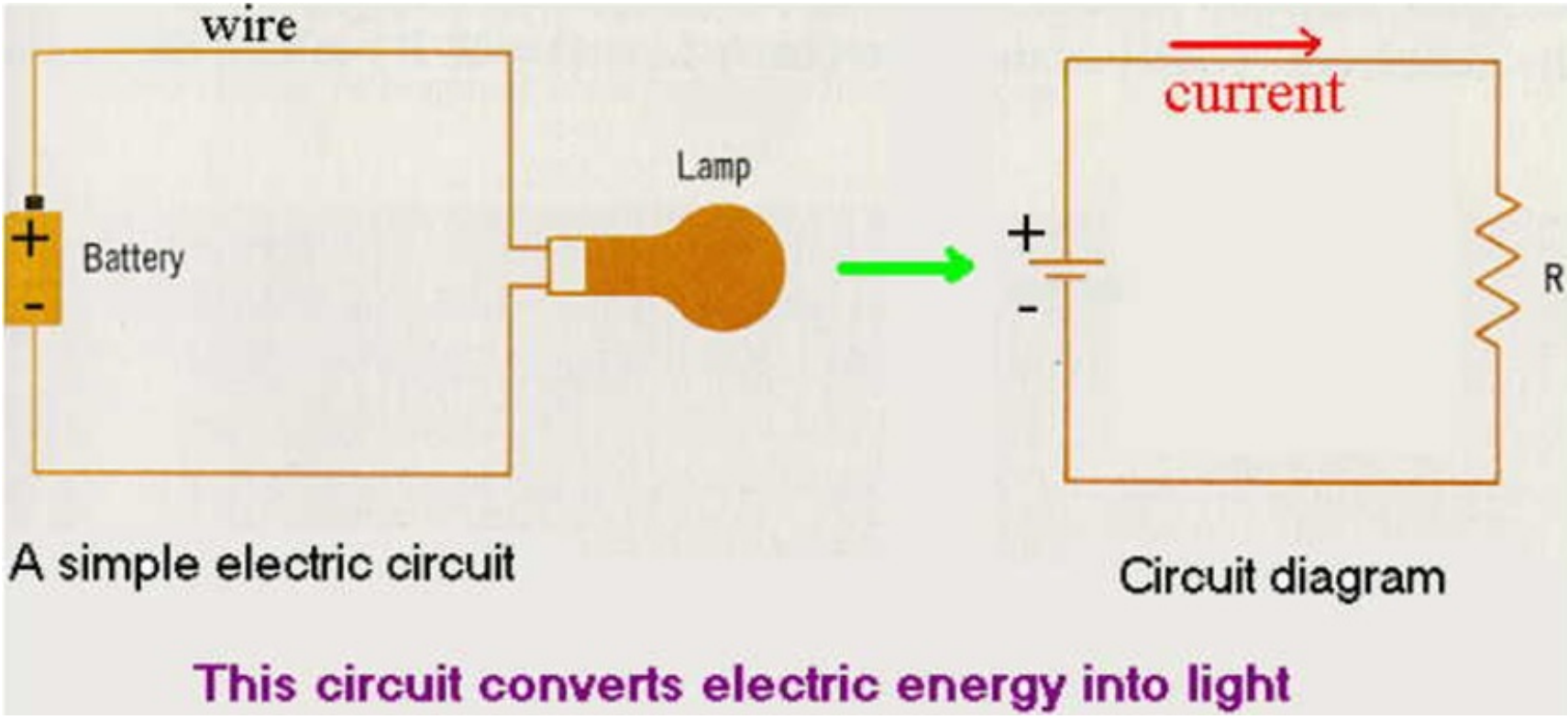

Figure: A circuit in which lamp is modeled as resistor

Circuit Terminologies

Usually, we use straight lines in circuits. A circuit is usually a rectangular figure, but this does not mean that in reality circuits are rectangular in shape

Current: denoted by i and I

Unit of current is Ampere

In real life, $1A$ is a big unit of current. A 1 ton split AC consumes 7 to 10 Amperes of current.

Circuit Terminologies

Formula for current:

$$i(t) = \frac{dq}{dt}$$

Ammeter: instruments used to measure current in a circuit

Voltmeter: instruments used to measure voltage between two points in a circuit

In-class Assignment 1

Question 1 - P1.2.6 on page 16: An electroplating bath, as shown in Fig. 1, is used to plate silver uniformly onto subjects such as kitchen-ware and plates. A current of $\mathbf{450}\boldsymbol{A}$ flows for $\mathbf{20}$ minutes, and each coulomb transports $\mathbf{1.118}\boldsymbol{mg}$ of silver. Compute the weight of silver deposited in grams.

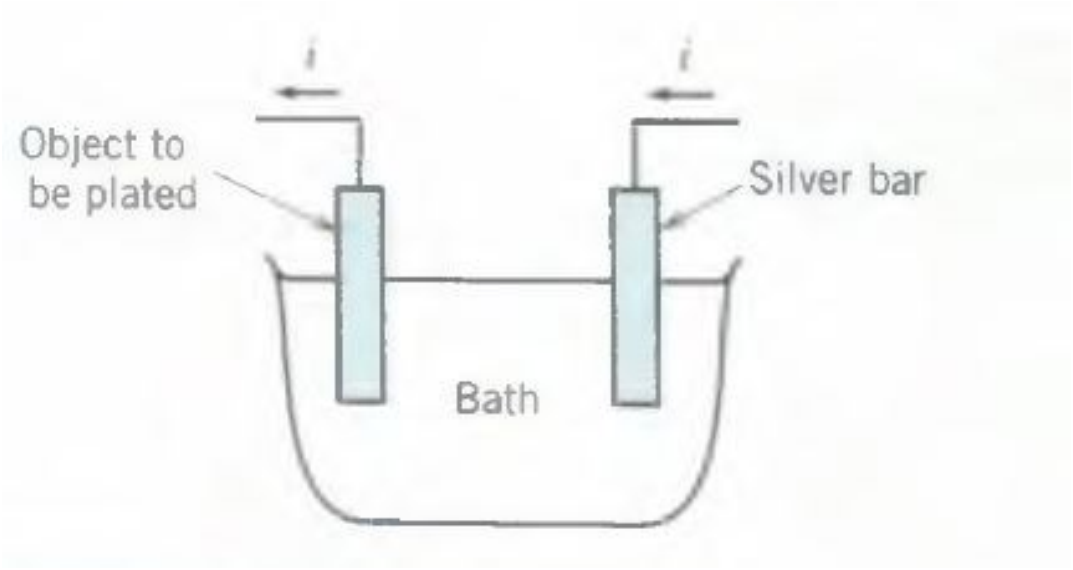

Figure: Figure to consider for solving Question 1

Ohm Law

Ohm Law states the following:

$$V = IR$$

More precisely, we can write the following:

$$v(t) = i(t)R$$

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Furthermore:

$$R = \rho \frac{L}{A}$$

where A is cross-sectional area, ρ is resistivity and L is length of the conductor.

Power

Power is expressed as follows:

$$p(t) = v(t)i(t)$$

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Energy is expressed as follows:

$$w = \int_{-\infty}^{t} p(\tau)d\tau$$

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Active element: supplies energy (like batteries, generators)

Passive element: absorbs energy (like resistor, capacitor and inductor)

Open and Short Circuit

Open Circuit: a path in which no current flows, and voltage is maximum (determined by examining the circuit)

Short Circuit: a path in which maximum current flows, and voltage drop is zero or minimum

Sources

A source is a voltage or current generator capable of supplying energy to a circuit

An **independent** source is a voltage or current generator which does NOT depend on other circuit variables

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An **independent** source is a voltage or current generator which does NOT depend on other circuit variables

Ideal voltage source: supplies constant voltage irrespective of the circuit connected to it

Ideal current source: supplies constant current irrespective of the circuit connected to it

Voltage Source

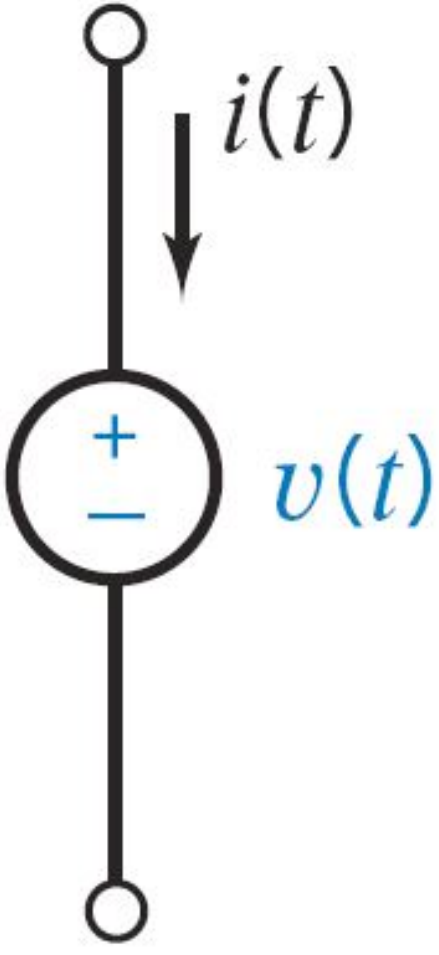


Figure: Independent voltage source symbol

Current Source

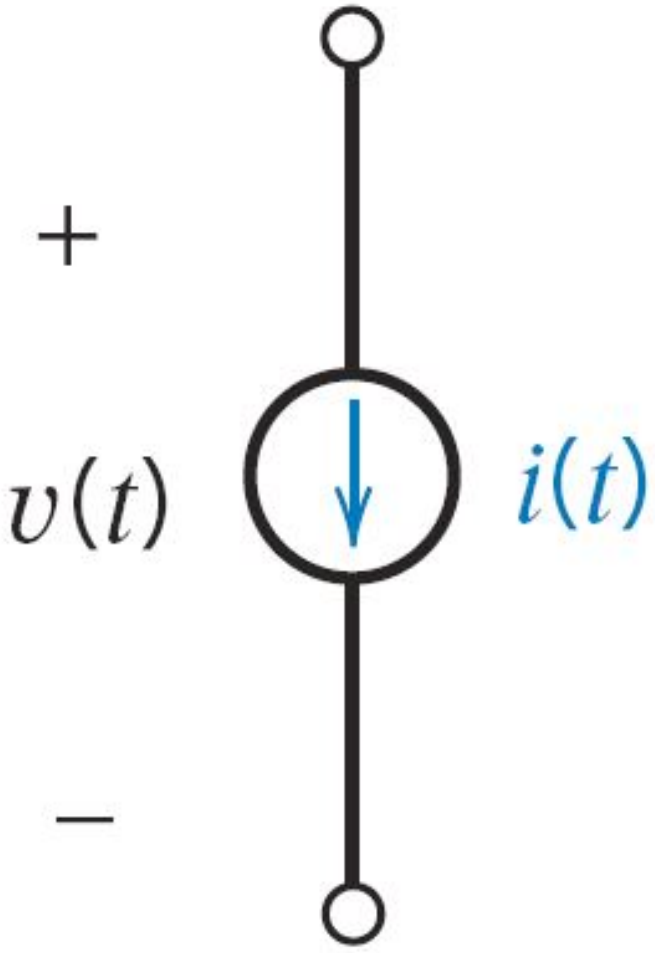
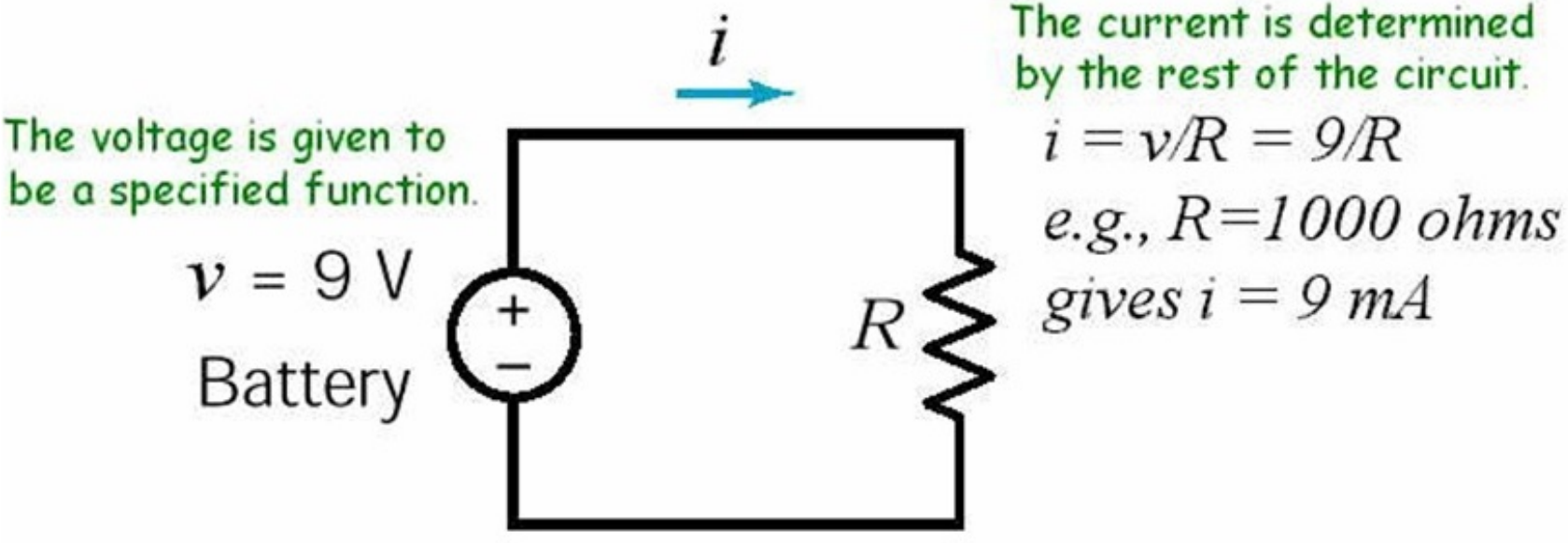


Figure: Independent current source symbol

Voltage Source Example

Example: 9V battery.



Series Combination of Sources

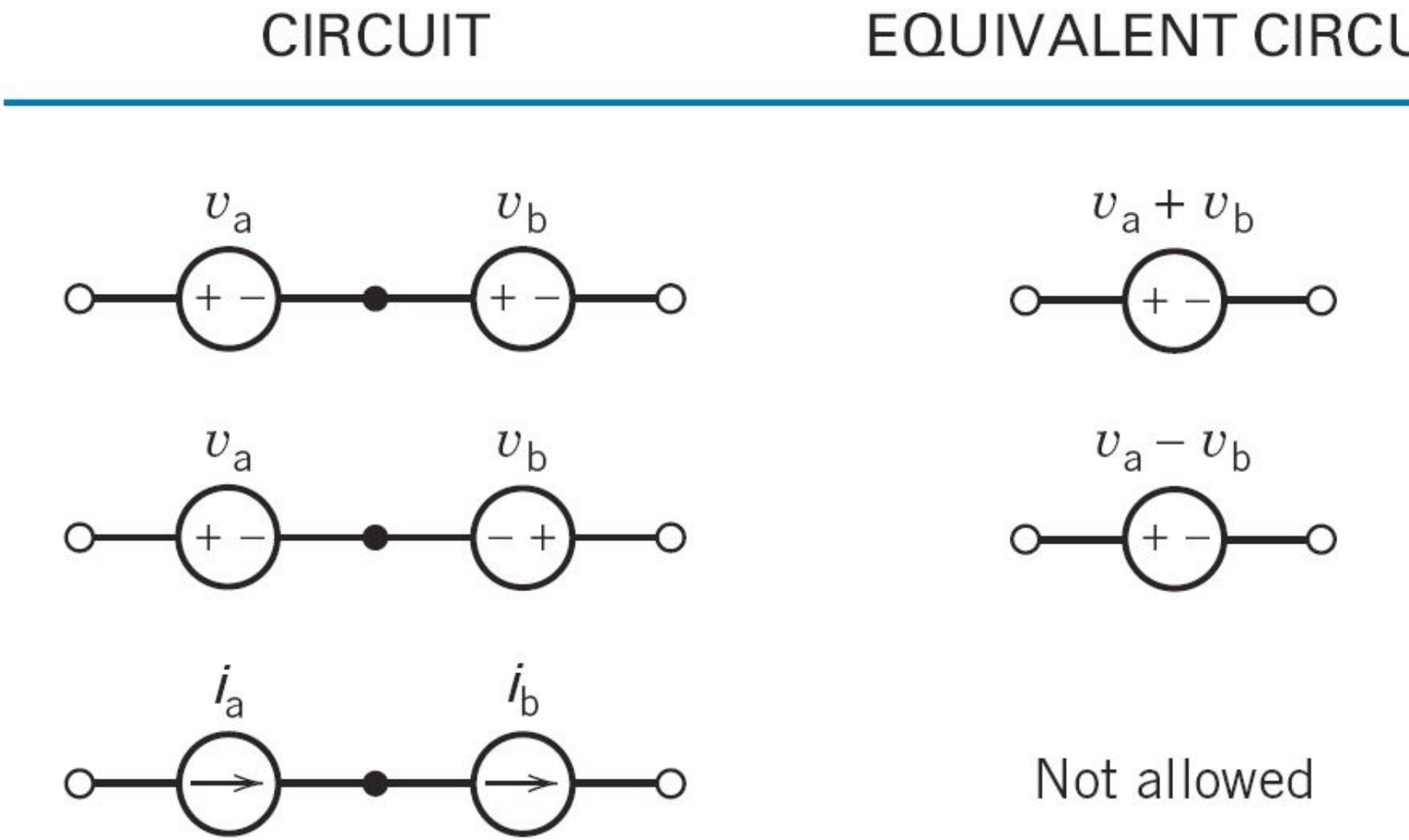


Figure: Series combination of sources

Parallel Combination of Sources

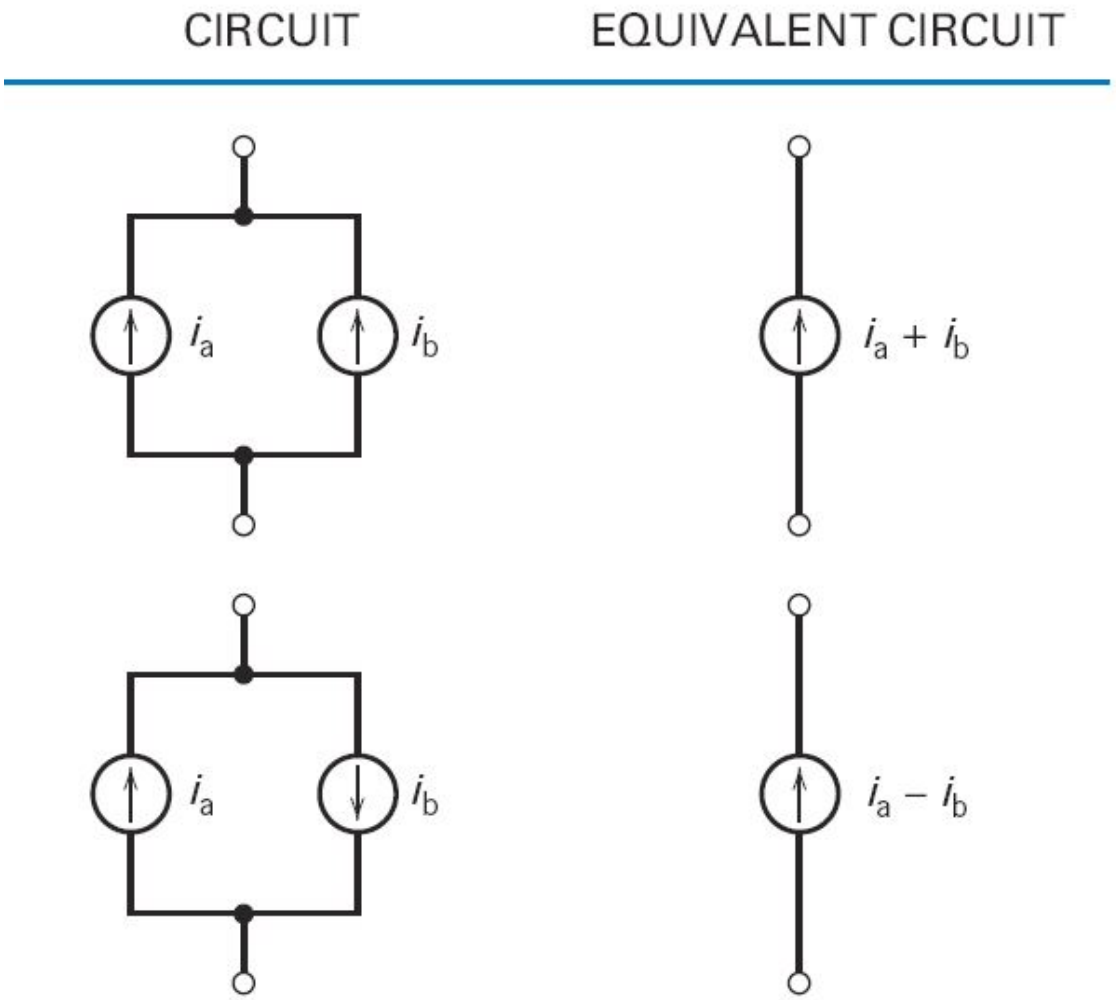
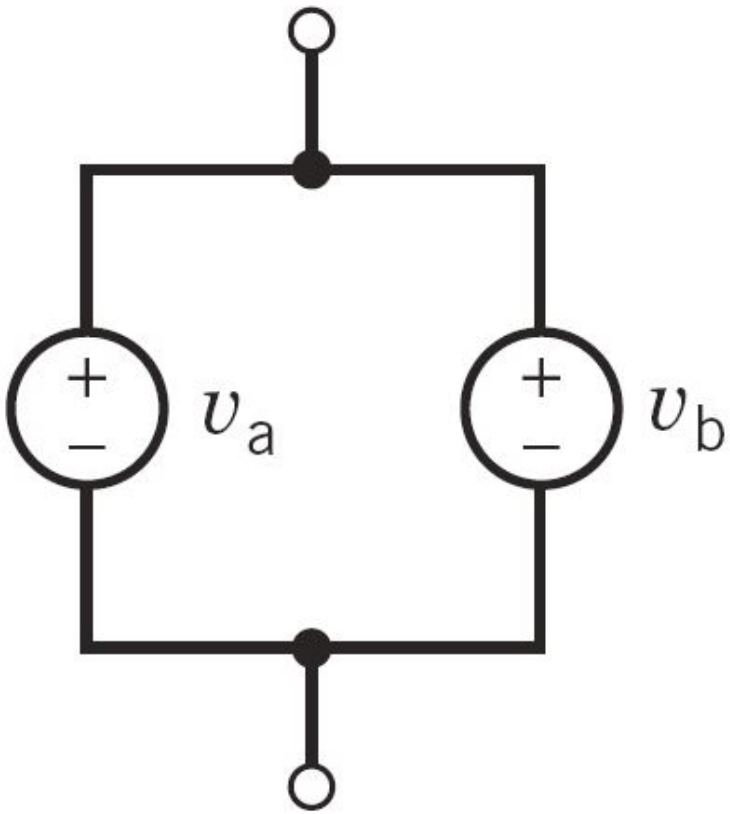


Figure: Parallel combination of sources

Parallel Combination of Voltage Sources



Not allowed

Figure: not allowed configuration unless $v_a = v_b$

Dependant Sources

There are four types of dependant sources, which are as follows:

1. Current-controlled Voltage source (CCVS)
2. Voltage-controlled Voltage source (VCVS)
3. Current-controlled Current source (CCCS)
4. Voltage-controlled Current source (VCCS)

Current-controlled VS

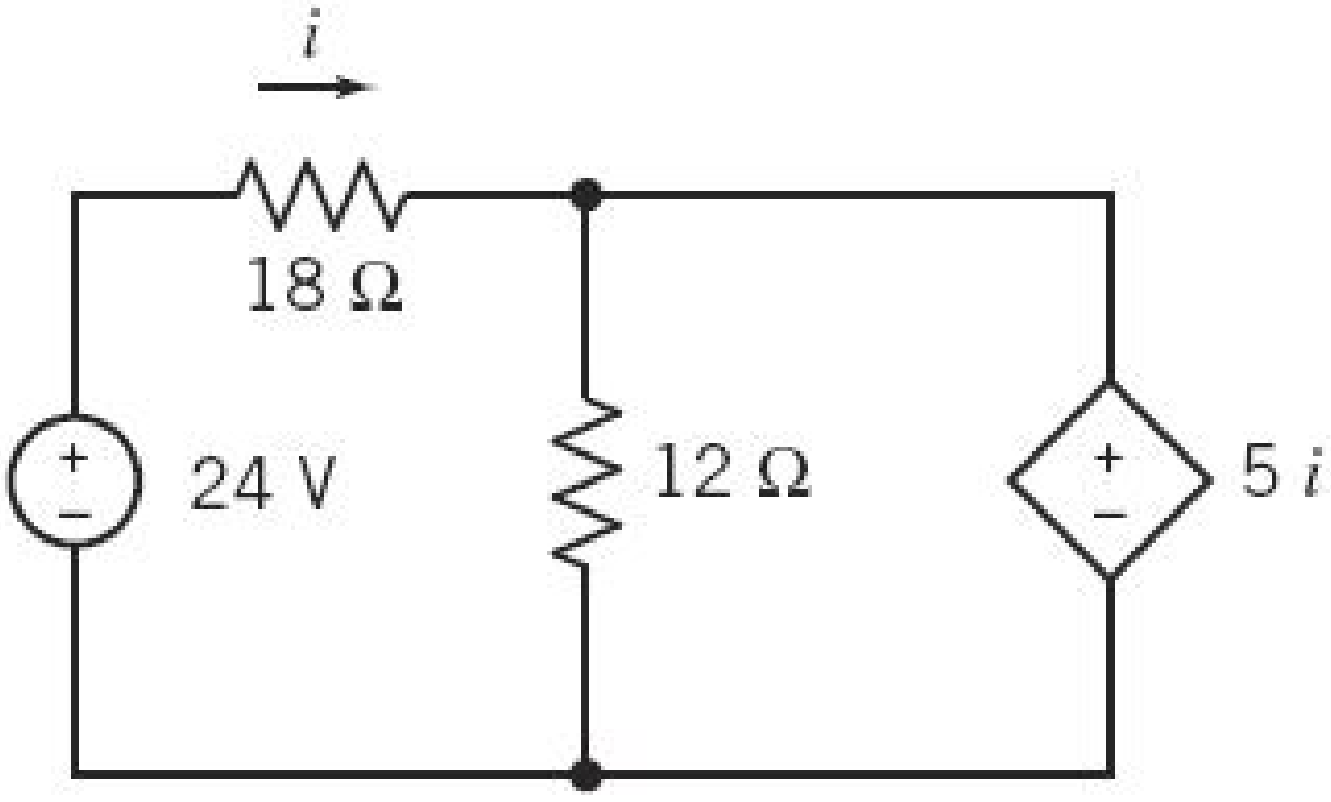


Figure: Current-controlled voltage source

Voltage-controlled CS

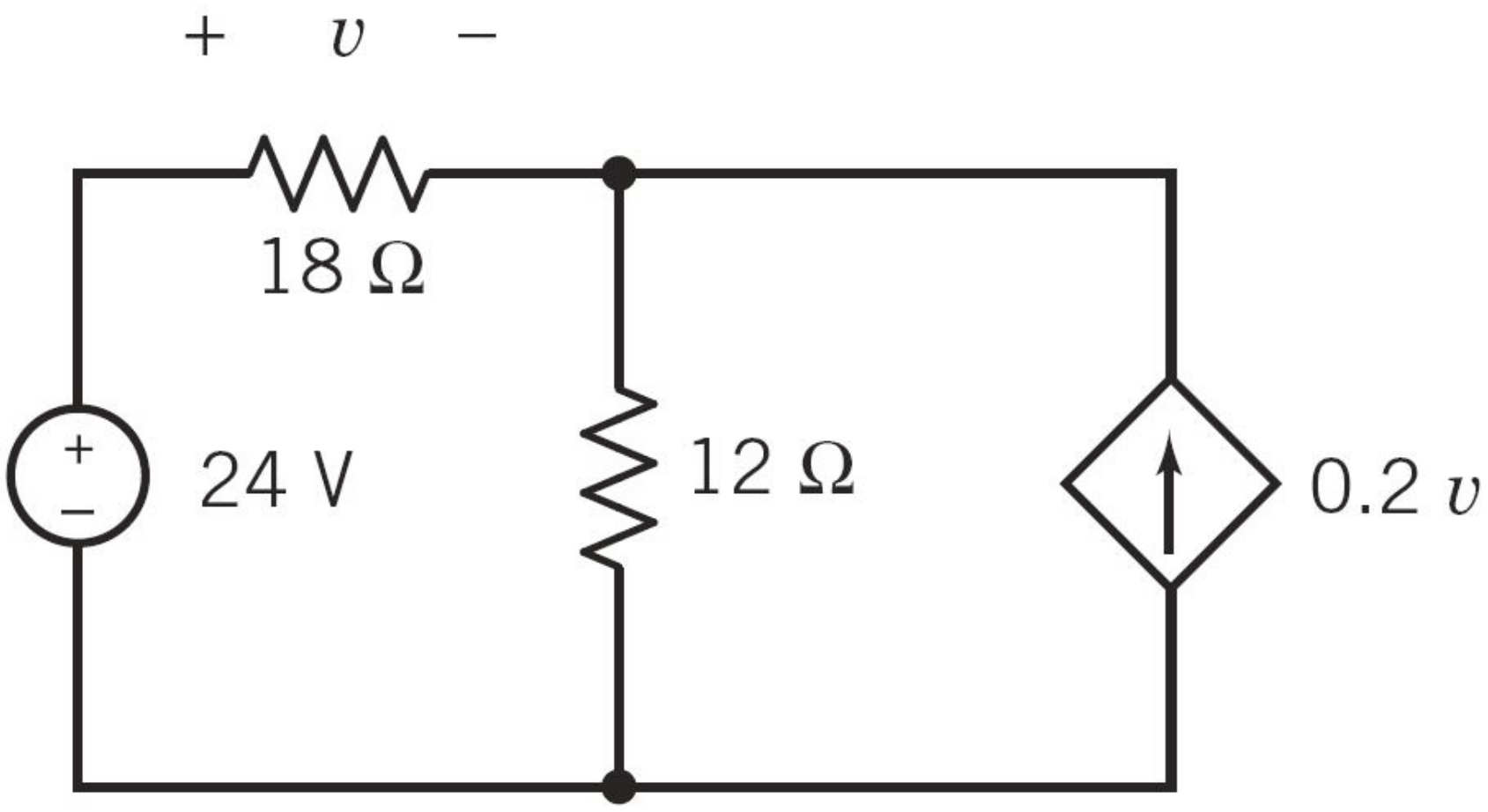


Figure: Voltage-controlled Current source

Transducers

Transducers: Devices that convert physical quantities into electrical quantities. Forexample: potentiometer, temperature sensor, digital thermometer, digital tire pressure meter

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Potentiometers: convert position to resistance

Temperature sensor: convert temperature into current

Potentiometer

Potentiometer: resistor having a movable (third) contact point which slides along the resistor

The movable contact point is also called wiper

In order to describe the value of a potentiometer, we need two parameters namely $\boldsymbol{R_p}$ and $\boldsymbol{a}$

The parameter $\boldsymbol{a}$ is between $\mathbf{0}$ and $\mathbf{1}$ i.e. $\mathbf{0} \leq \boldsymbol{a} \leq \mathbf{1}$. If $\boldsymbol{a} = \mathbf{0}$, it indicates one extreme point and if $\boldsymbol{a} = \mathbf{1}$, then it indicates the second extreme point of the wiper

Potentiometer

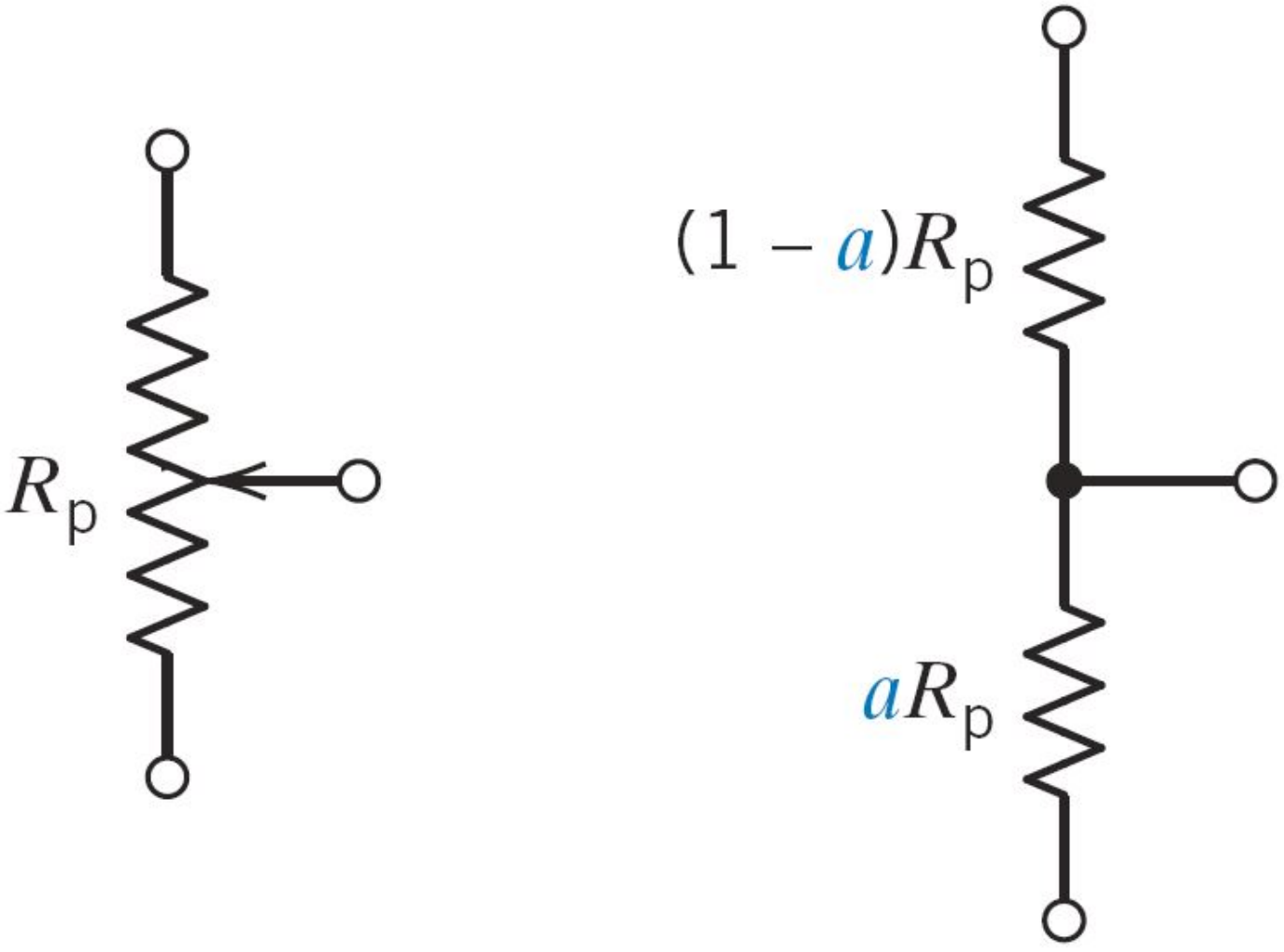

Figure: Model of Potentiometer

Potentiometer and Temperature Sensor

$\boldsymbol{R_p}$ is known, but how to determine the value of $\boldsymbol{a}$?

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The parameter $\boldsymbol{a}$ depends on the angle $\boldsymbol{\theta}$ of the dial which is given as follows:

$$\boldsymbol{a = \frac{\theta}{360}}$$

Potentiometer and Temperature Sensor

R_p is known, but how to determine the value of a?

The parameter a depends on the angle θ of the dial which is given as follows:

$$a = \frac{\theta}{360}$$

Temperature sensors (e.g. AD590) give current as output based on temperature values. Usually, there is an operating voltage for temperature sensors

$$4 \leq v \leq 30$$

The output of temperature sensor is

$$i = k.T$$

Temperature Sensor

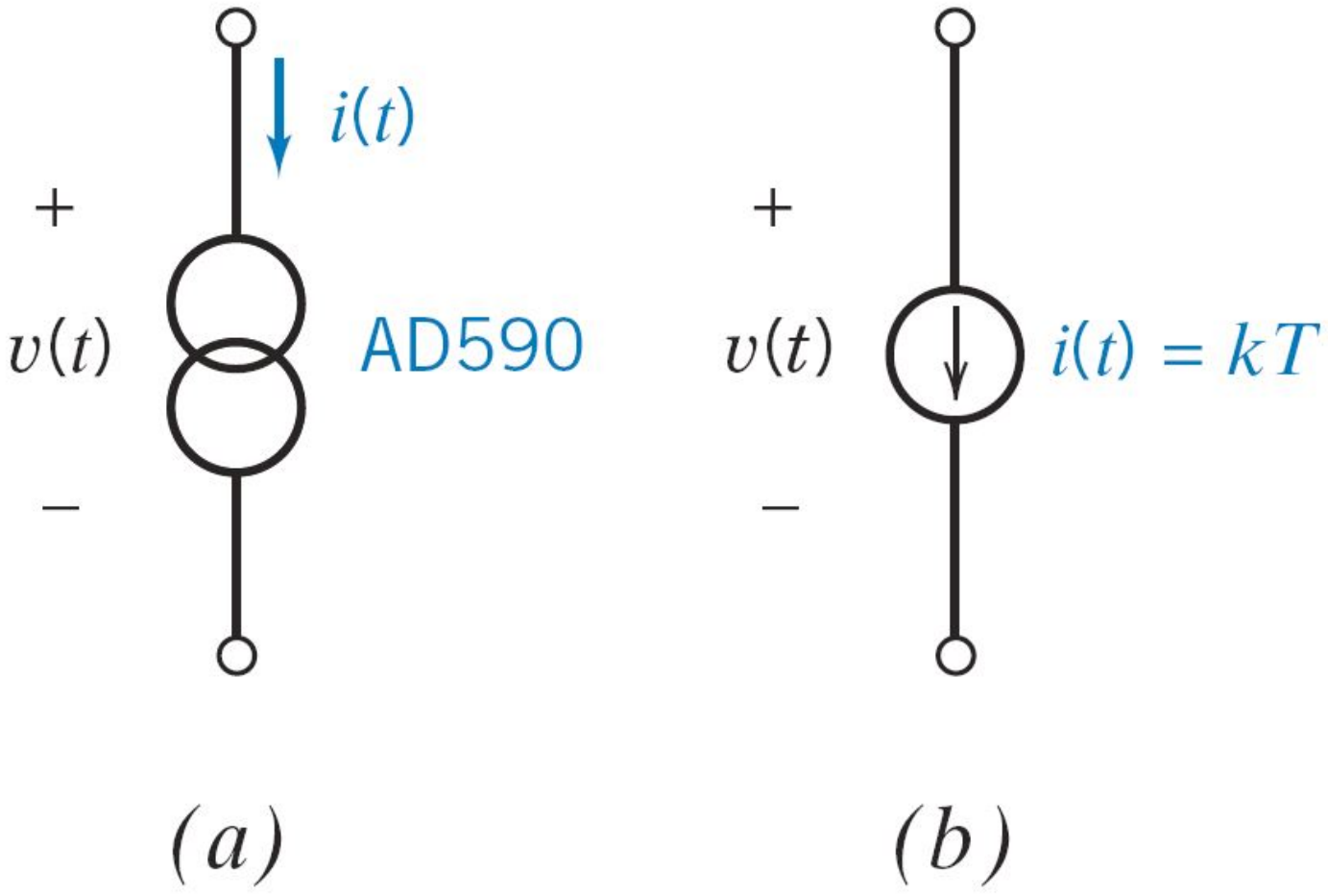

Figure: Symbol and model of Temperature Sensor

Next week topics

Next week, we will be studying switches (topic 2.9 of textbook)

We will also practice and solve exercise questions from chapter 2.