University of Anbar
College of Engineering
Dept. of Electrical Engineering

Fundumantal of Electronic I

Second Class

Chapter02: Diode Applications
Lec02_p4

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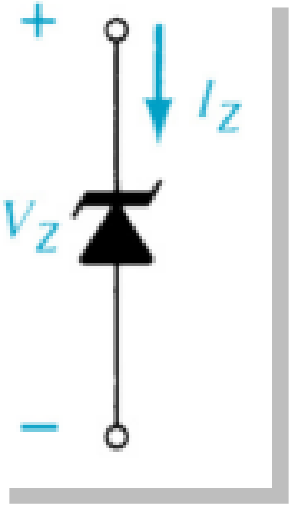
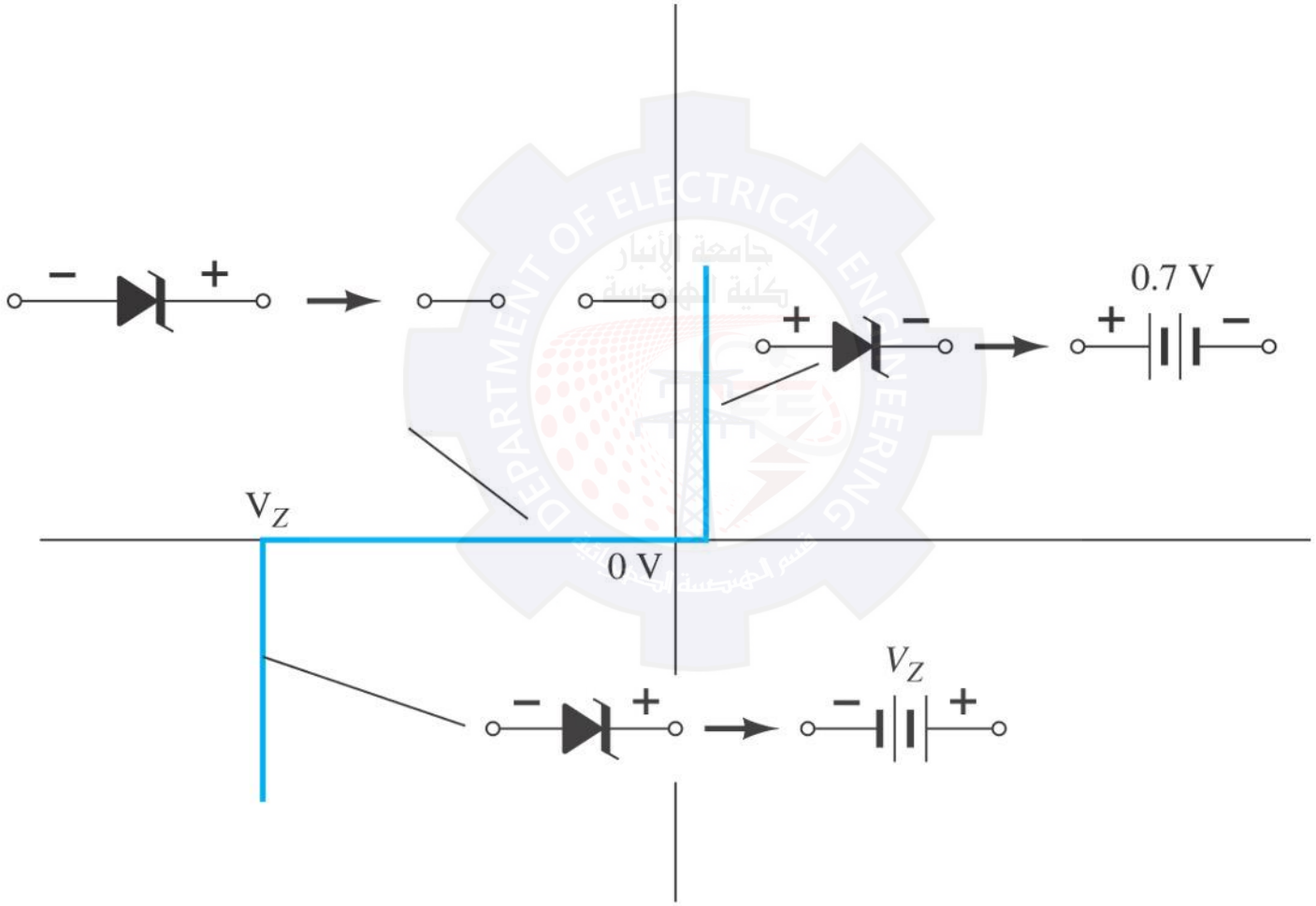
2019-2020

Zener Diodes

- A **Zener diode** is a type of diode that permits current not only in the forward direction like a normal diode, but also in the reverse direction if the voltage is larger than the breakdown voltage known as "Zener voltage“ **(V_Z)**.
- Common Zener voltages are between 1.8 V and 200 V.
- Zener diode is used as regulator.



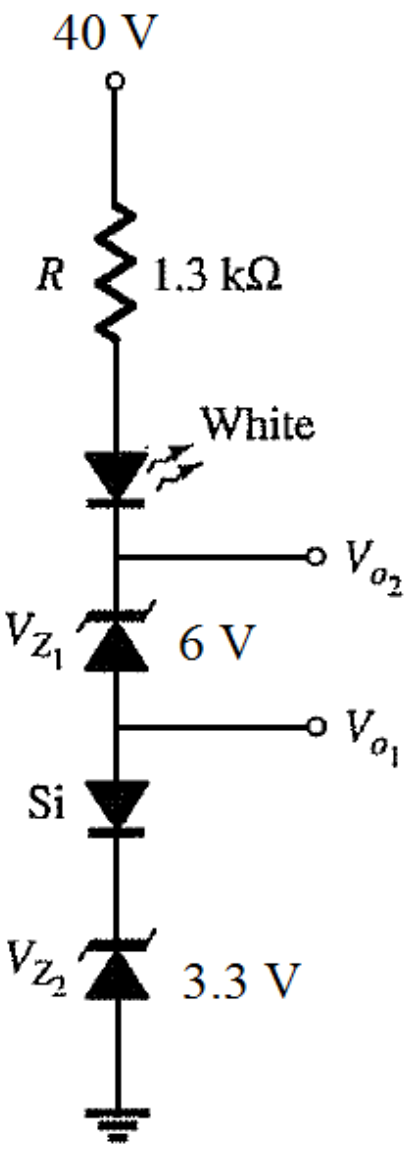
Zener Diodes



Approximate equivalent circuits for the Zener diode in the three possible regions of application.

Example 2.24

Determine the reference voltages provided by the network which uses a white LED (4V) to indicate power is on. What is the power delivered to the LED and to the 6 V Zener diode.



$$V_{o1} = V_{Z2} + V_K = 3.3 + 0.7 = 4V$$

$$V_{o2} = V_{o1} + V_{Z1} = 4 + 6 = 10V$$

The 4-V across the white LED

$$I_R = I_{LED} = \frac{40 - V_{o2} - V_{LED}}{1.3k} = \frac{40 - 10 - 4}{1.3k} = \frac{26}{1.3k} = 20mA$$

the power delivered by the supply

$$P_S = E \times I_S = E \times I_R = (40V) \times (20mA) = 800mW$$

the power absorbed by the LED

$$P_{LED} = V_{LED} \times I_{LED} = (4V) \times (20mA) = 80mW$$

the power absorbed by 6-V Zener diode

$$P_Z = V_Z \times I_Z = (6V) \times (20mA) = 120mW$$

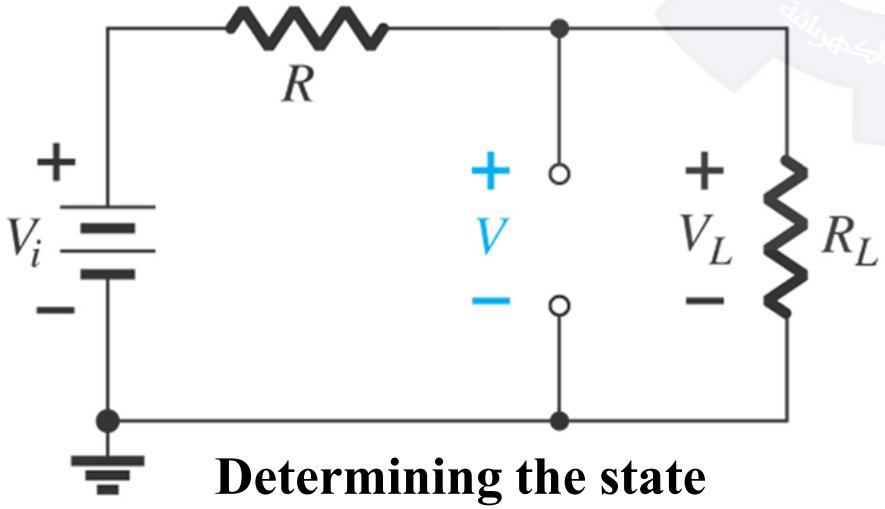
Basic Zener Regulator

Remove Zener diode from network.

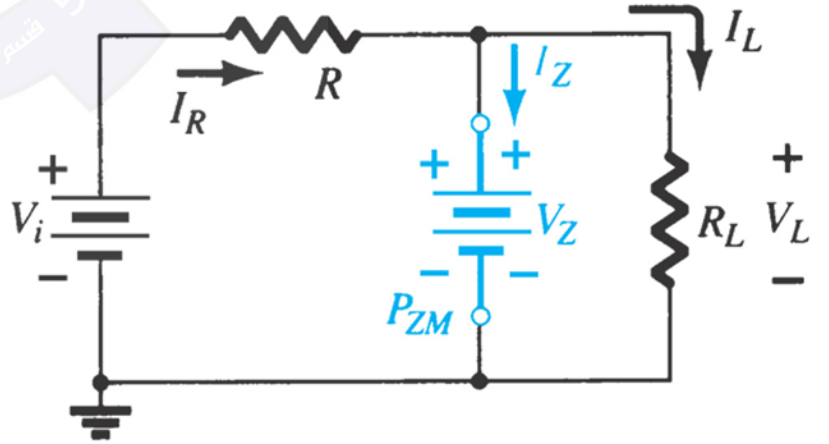
Calculate ***V*** across open circuit.

If ***V***≥Vz , Zener diode is on.

If ***V***<Vz, Zener diode is off.



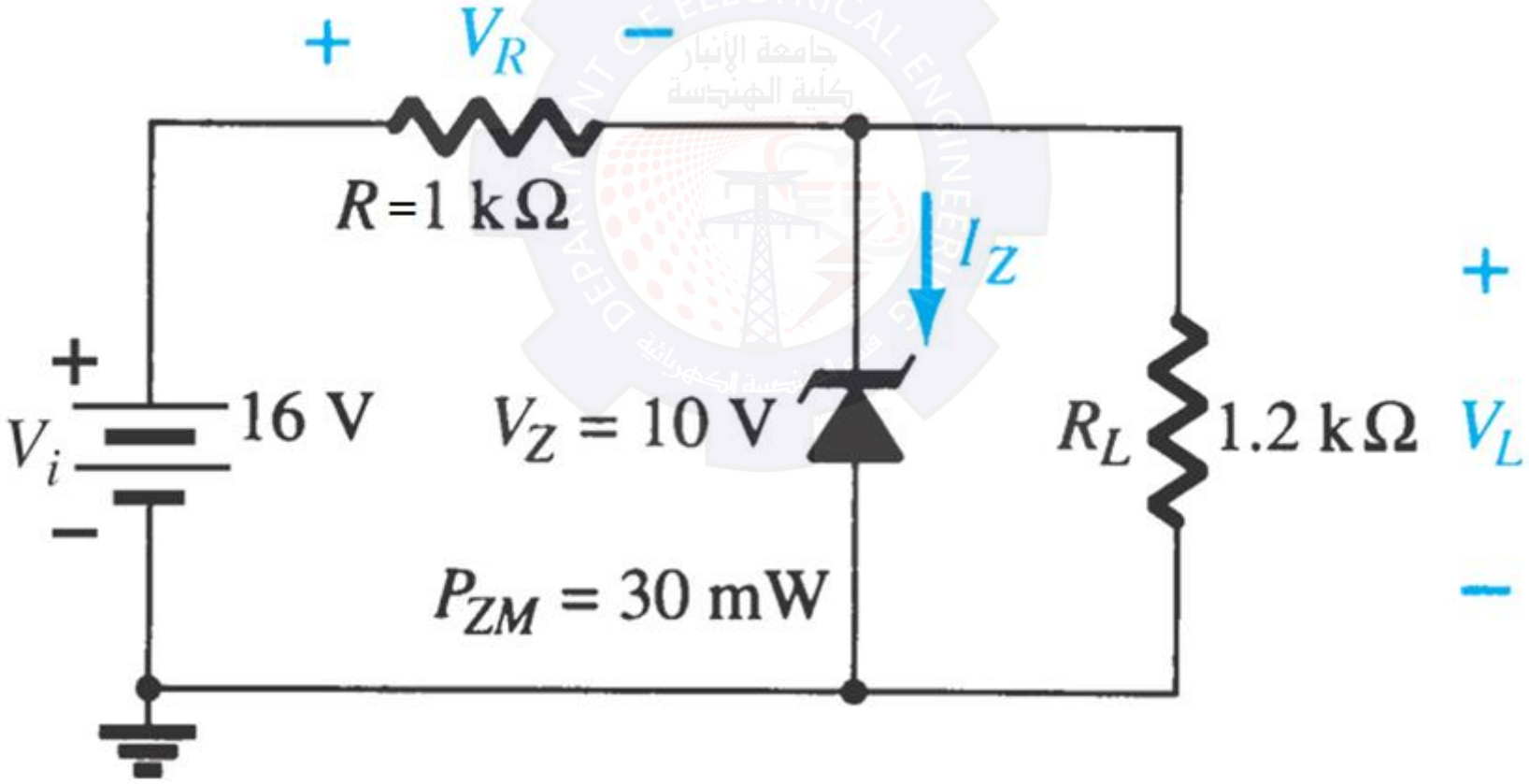
Determining the state of the Zener diode.



Substituting the Zener equivalent for the "on" situation

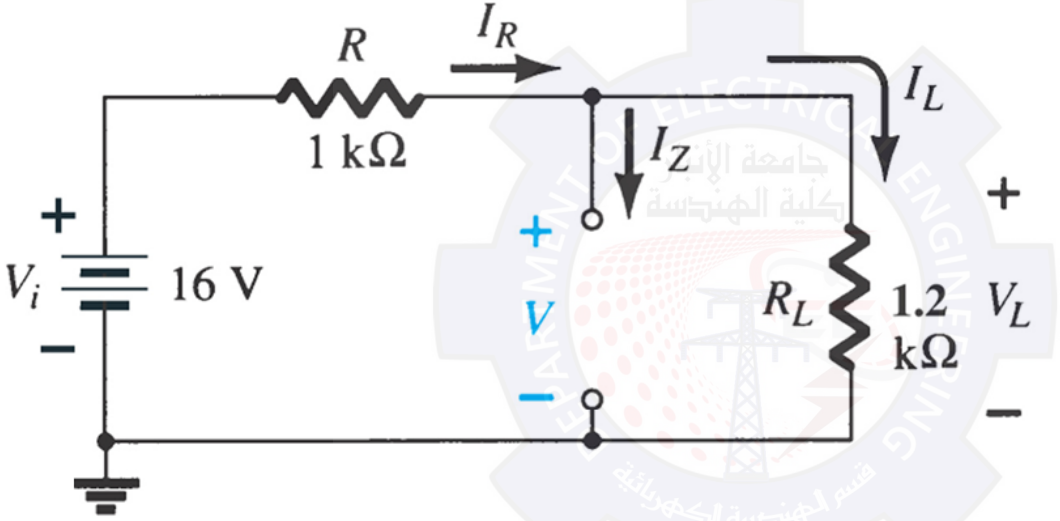
Example 2.26

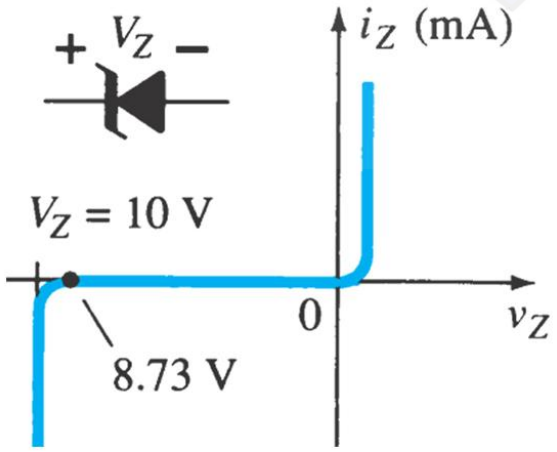
(a) For the Zener diode network, determine V_L, V_R, I_Z and P_Z.
(b) Repeat part (a) with R_L=3 kΩ.



Example 2.26 - Solution

(a) determine V_L, V_R, I_Z and P_Z. (R_L=1.2 kΩ)

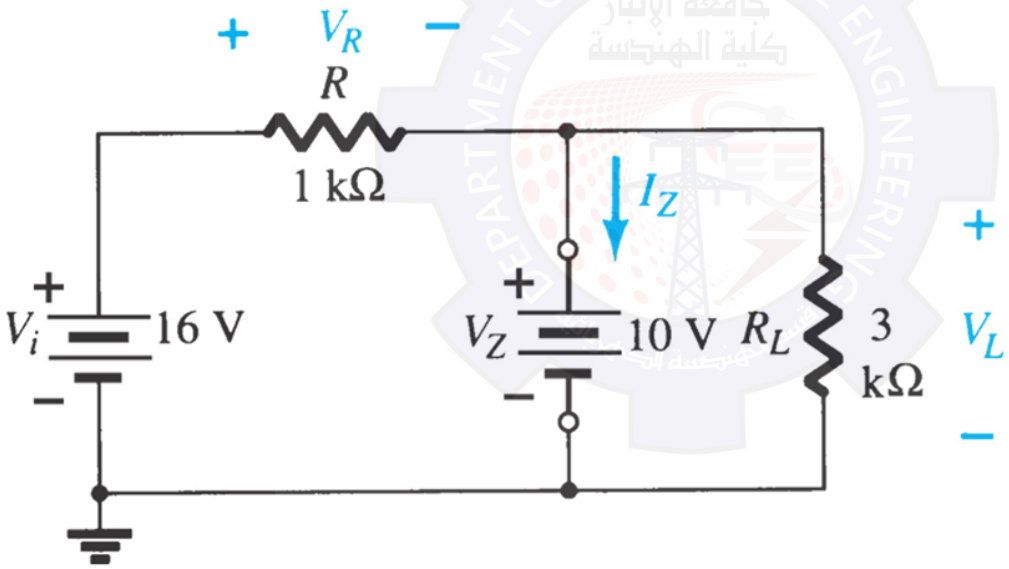




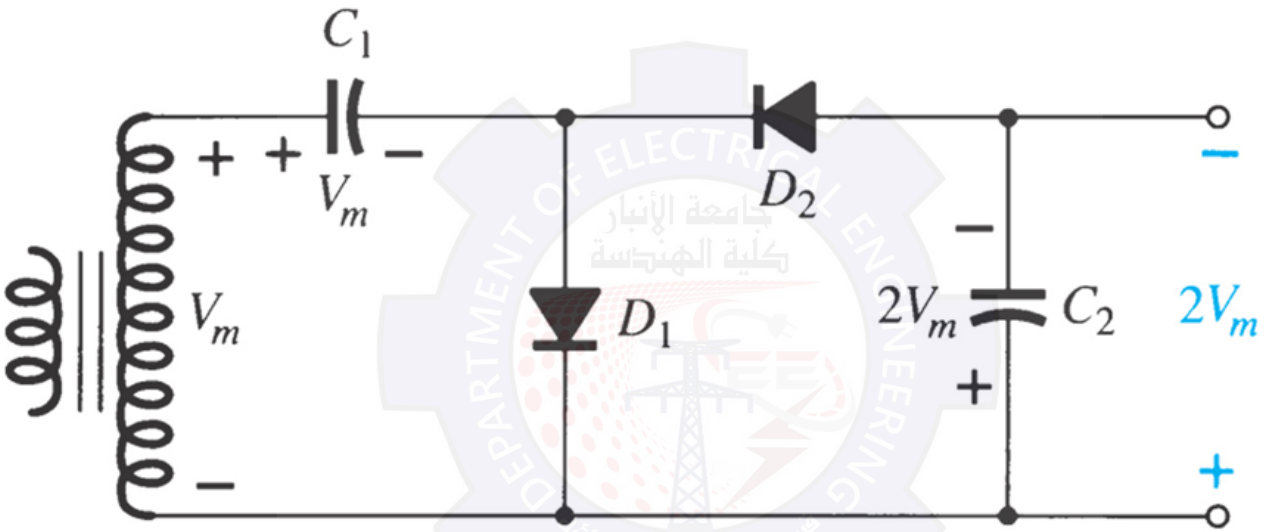
V=8.73 V (<10)
I_Z=0

Example 2.26 - Solution

(b) determine V_L, V_R, I_Z and P_Z. (R_L=3 kΩ)



Voltage Doubler



This half-wave voltage doubler's output can be calculated by:

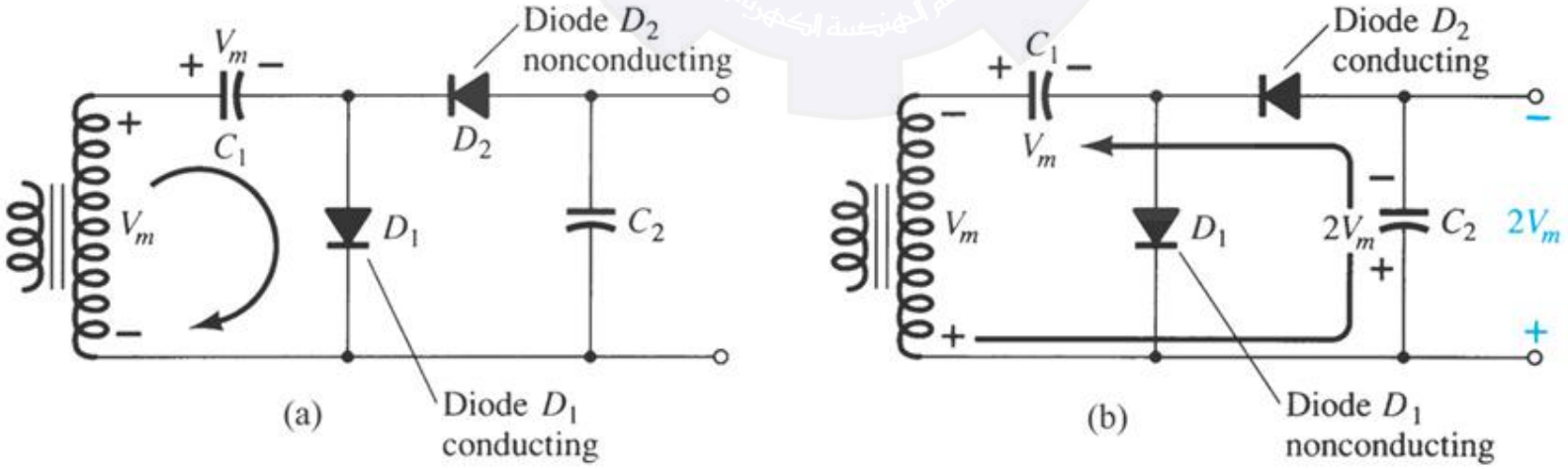
$$V_{out} = V_{C2} = 2V_m$$

where V_m = peak secondary voltage of the transformer

Voltage Doubler

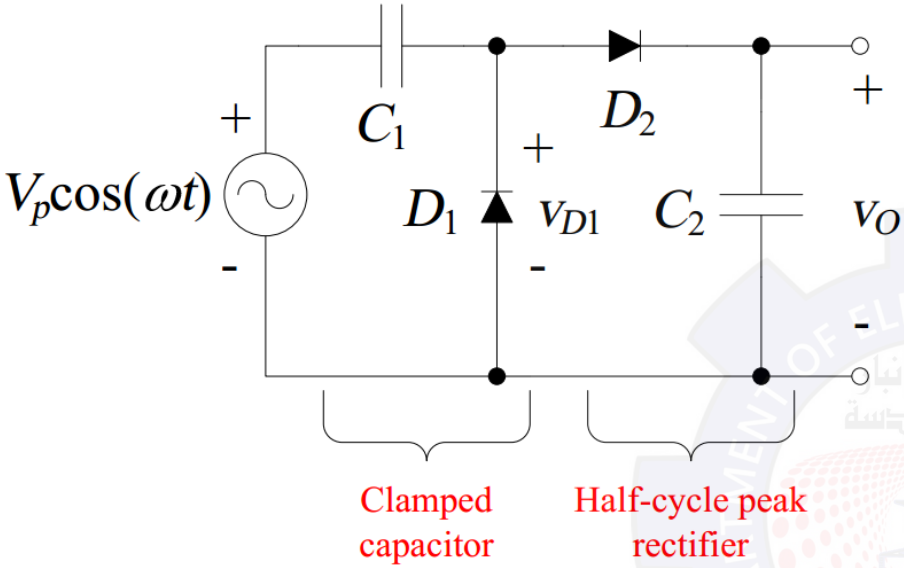
- **Positive Half-Cycle**
  - **D_1 conducts**
  - **D_2 is switched off**
  - **Capacitor C_1 charges to V_m**
- **Negative Half-Cycle**
  - **D_1 is switched off**
  - **D_2 conducts**
  - **Capacitor C_2 charges to $2V_m$**

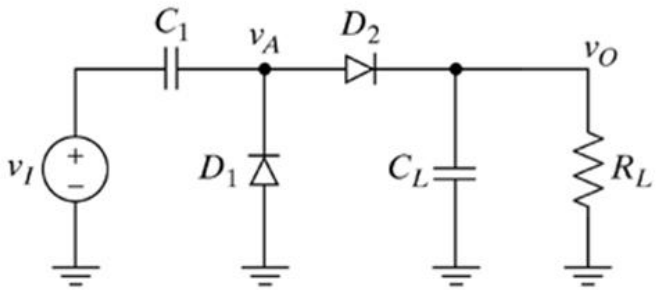
$$V_{out} = V_{C2} = 2V_m$$

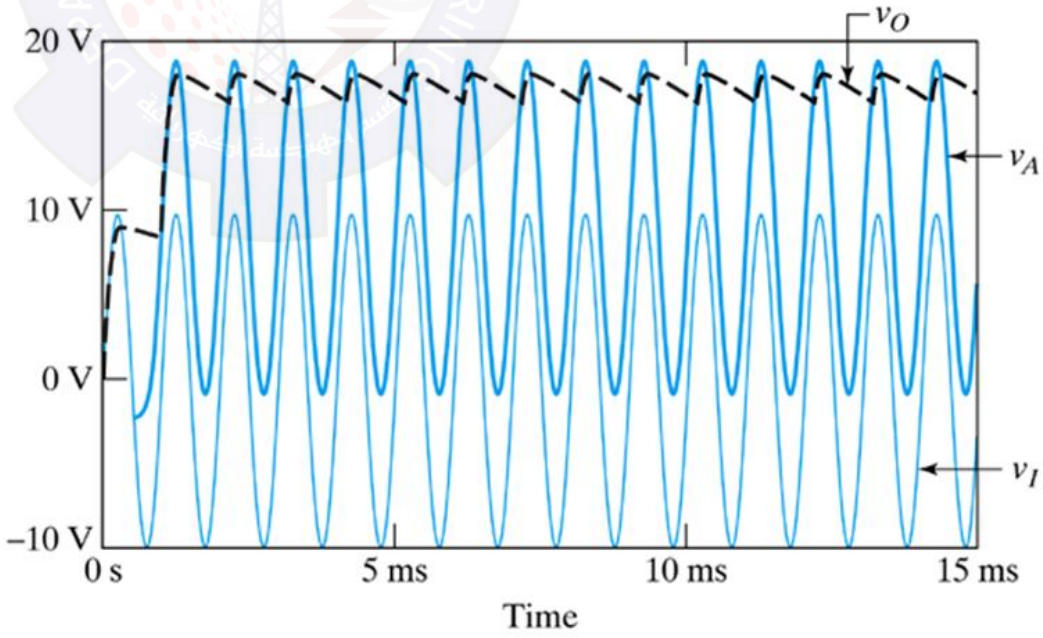


(a) positive half-cycle; (b) negative half-cycle.

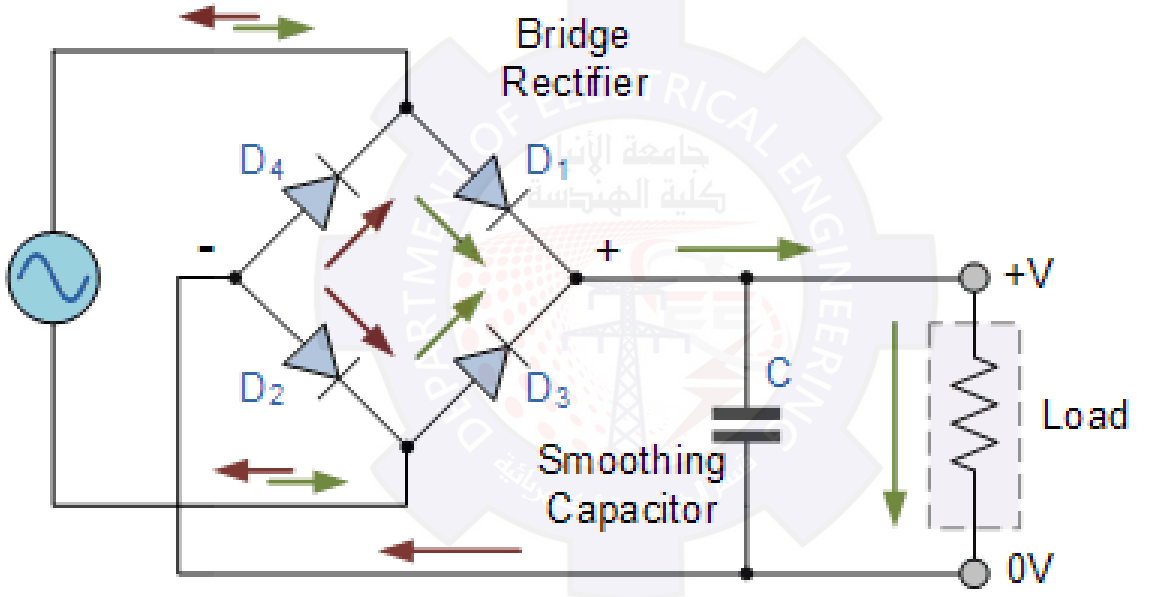
Voltage Doubler

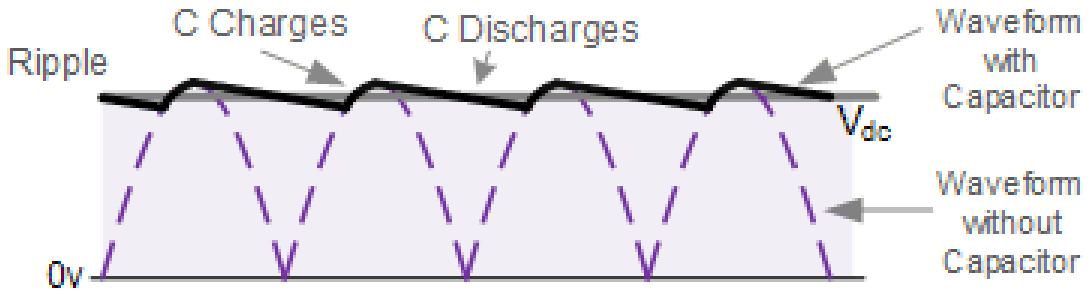






Practical Applications
(AC to DC Converter)

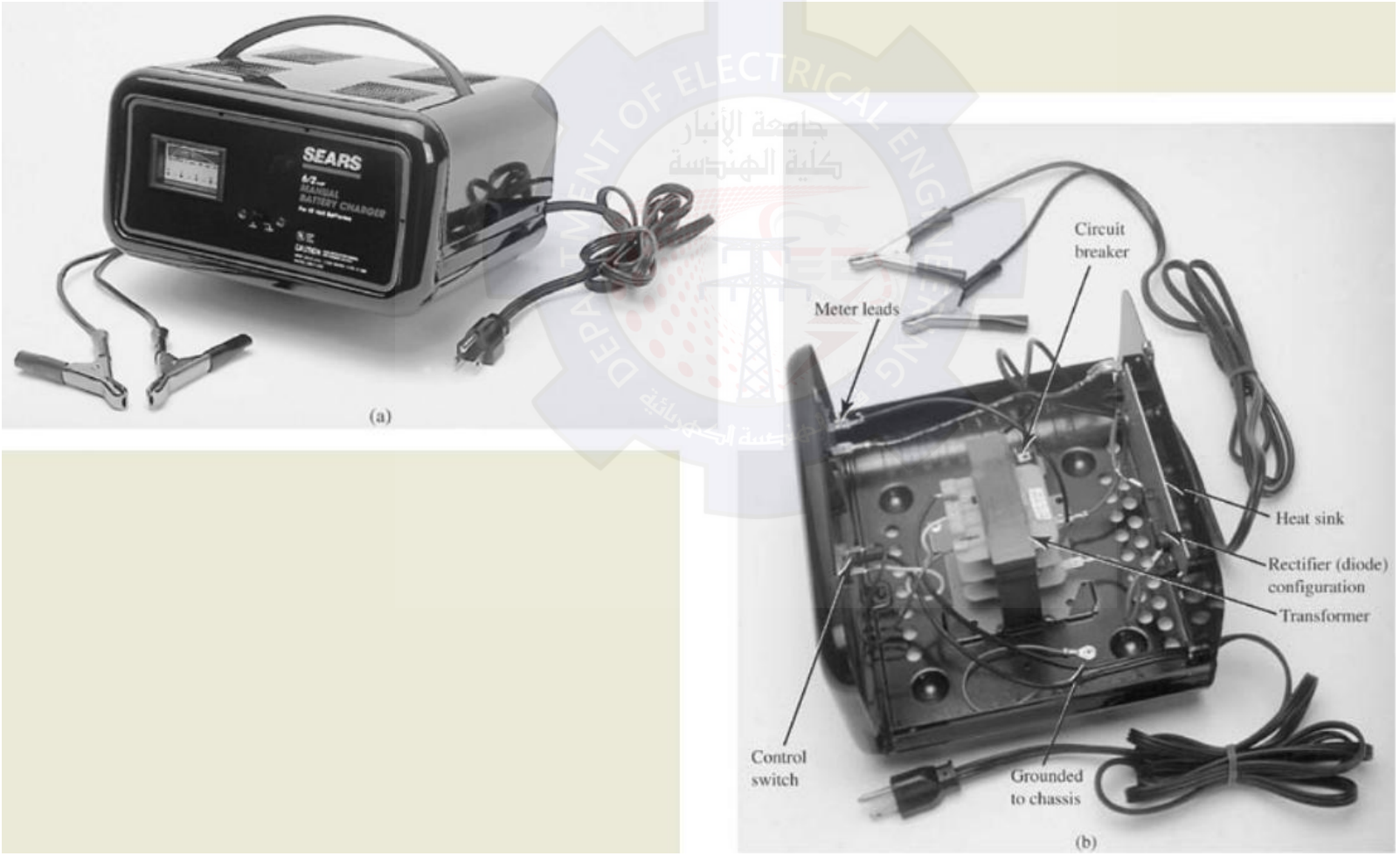




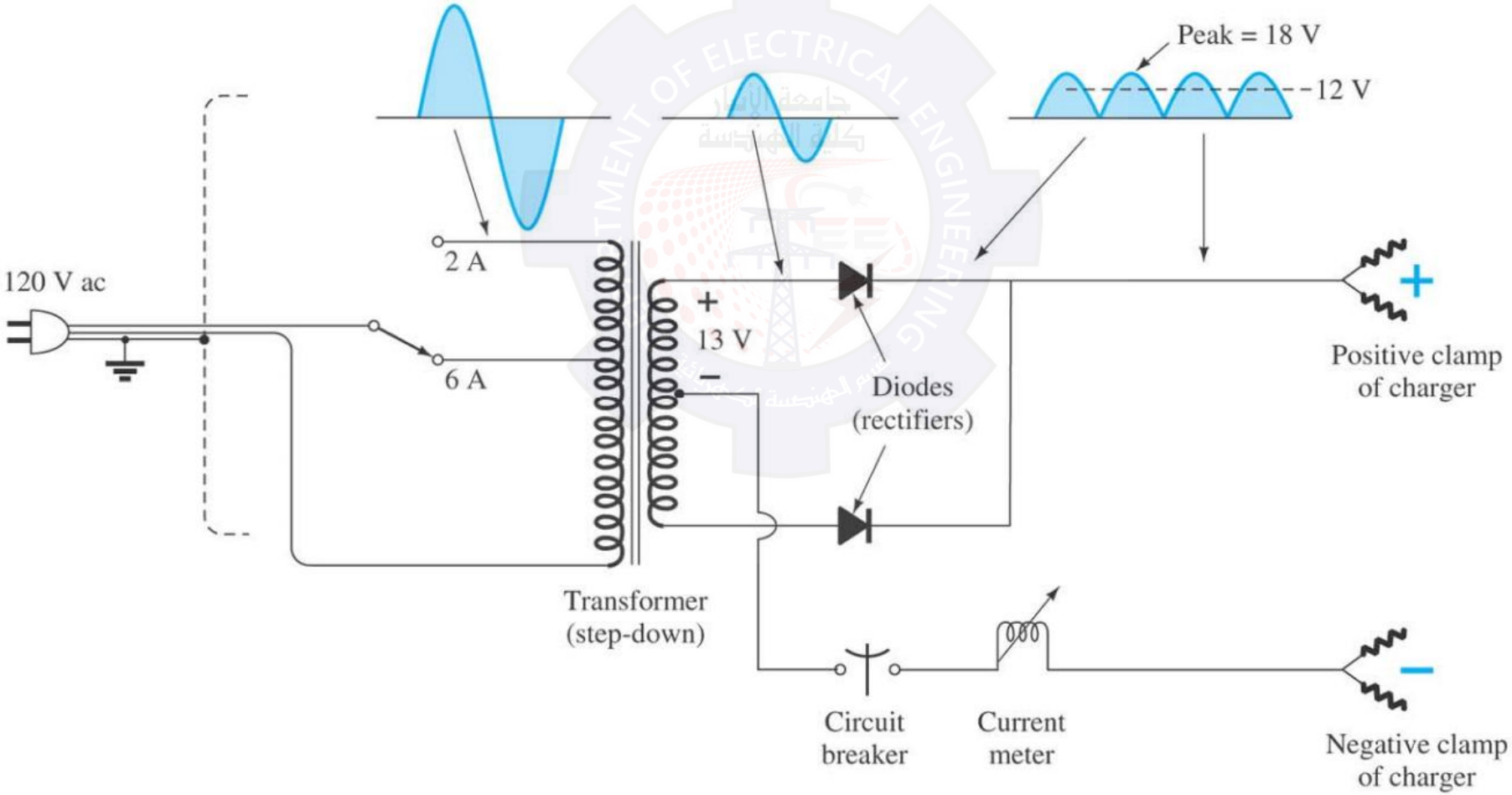
Resultant Output Waveform

Practical Applications

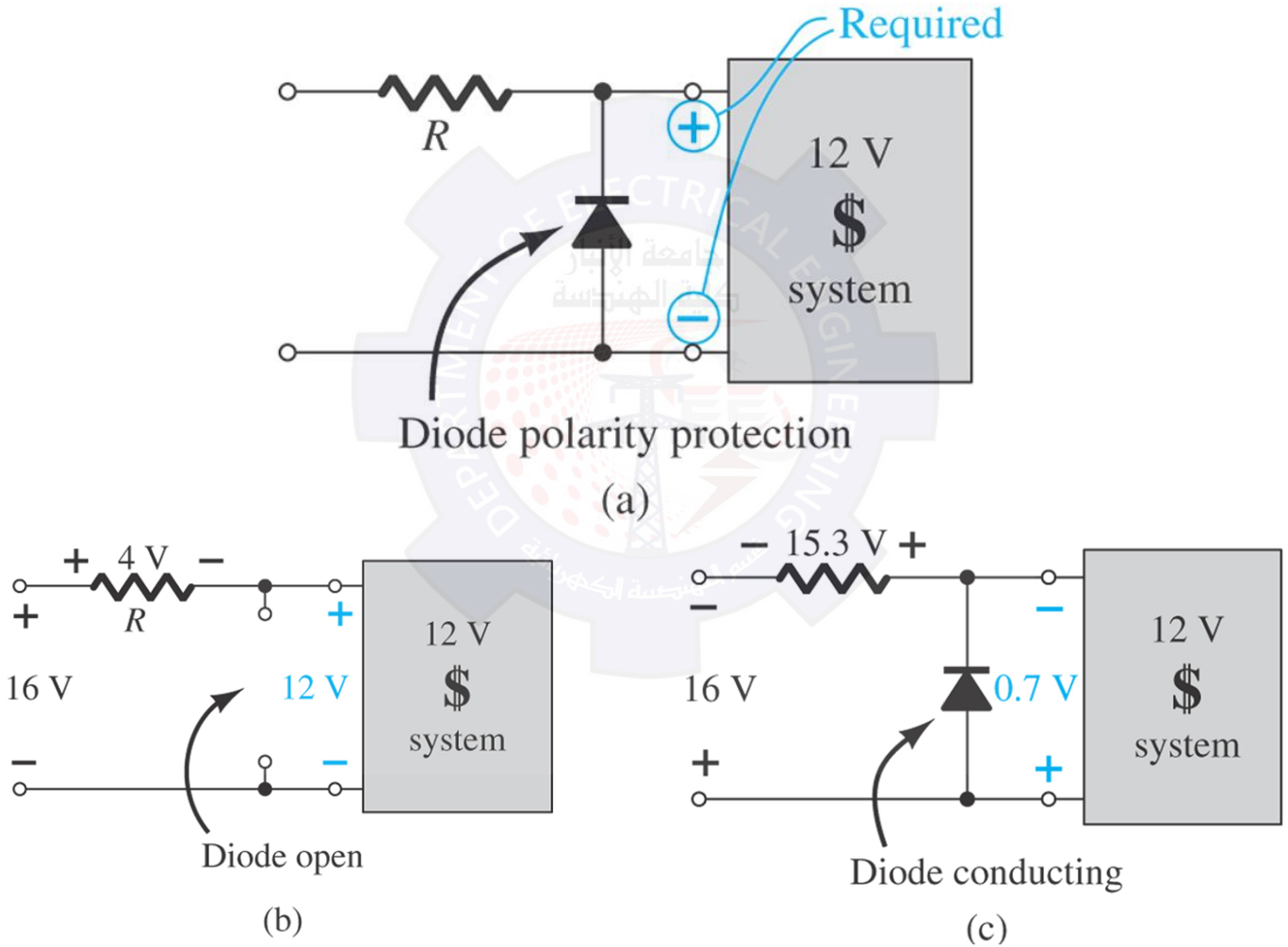
Battery Charger



Practical Applications
Battery Charger

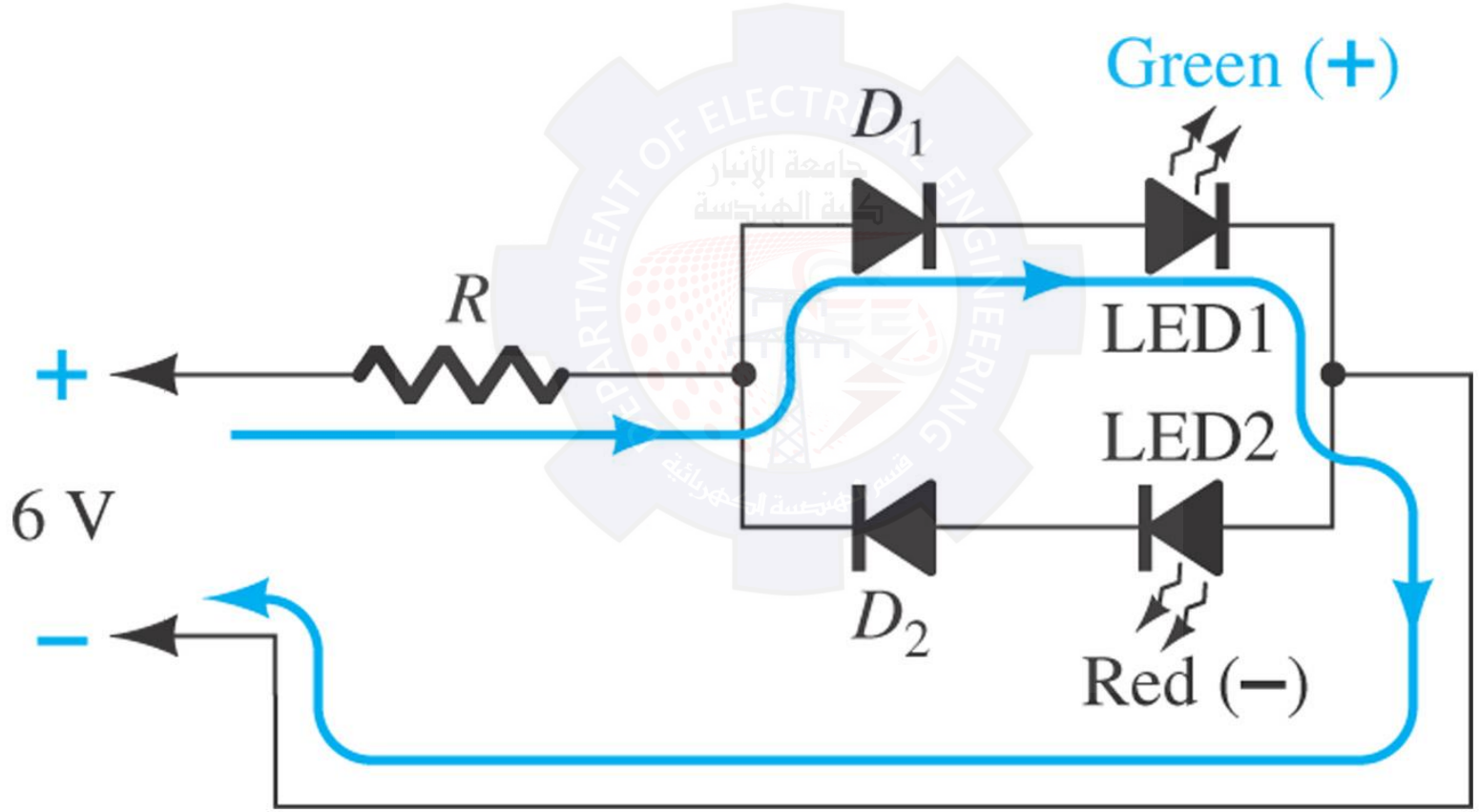


Practical Applications - Polarity insurance



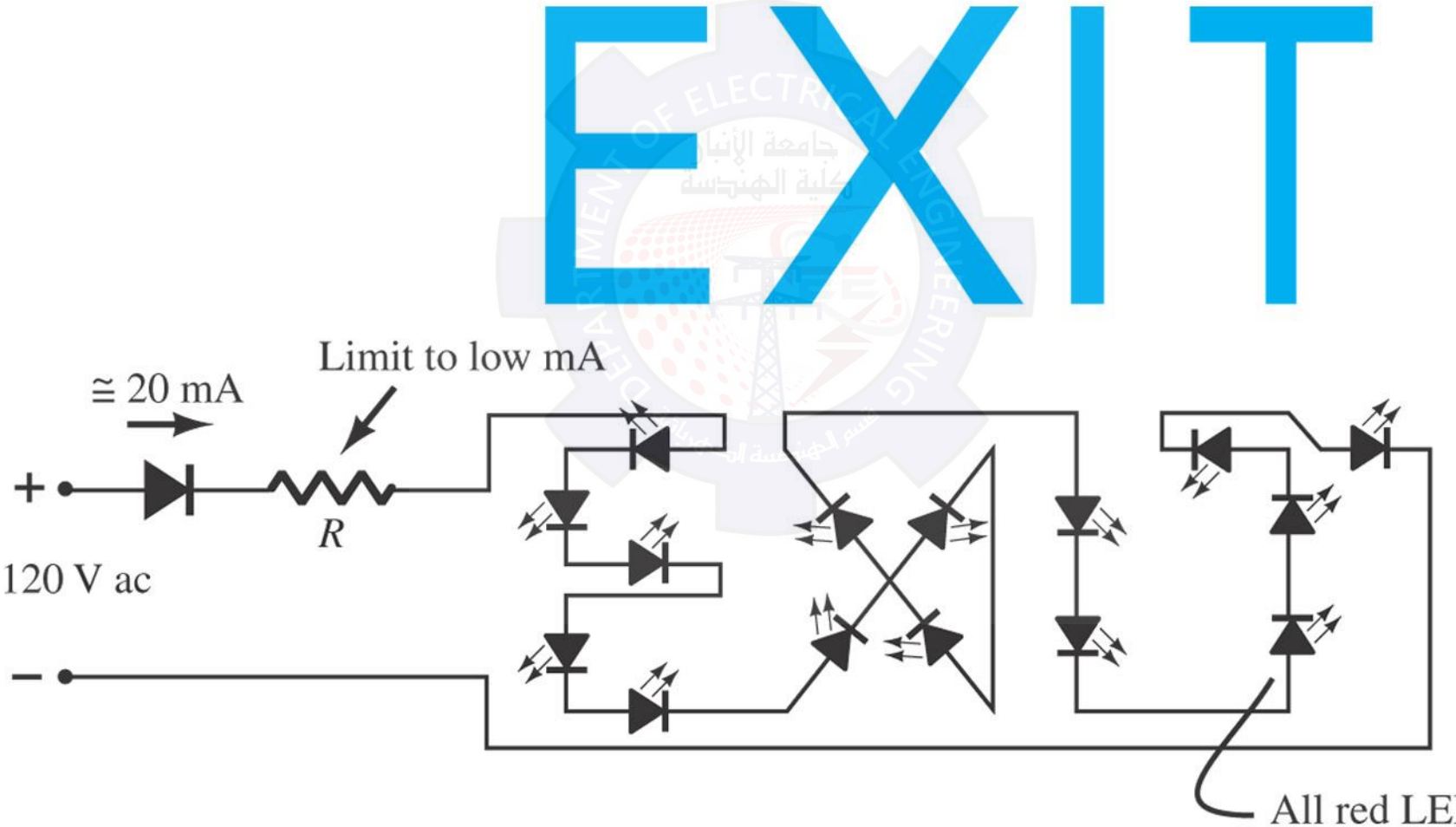
(a) Polarity protection for an expensive, sensitive piece of equipment; (b) correctly applied polarity; (c) application of the wrong polarity.

Practical Applications - Polarity Detector

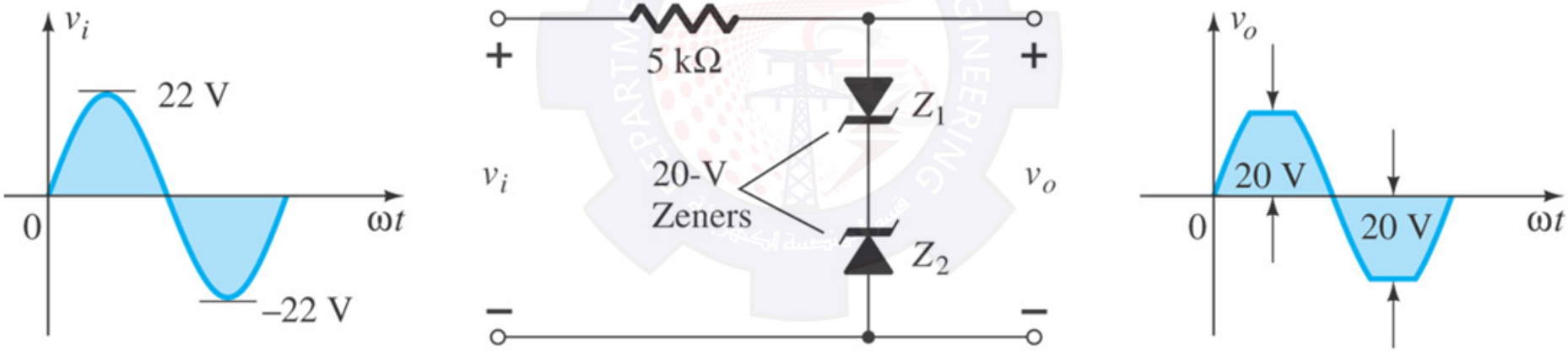


Polarity detector using diodes and LEDs.

Practical Applications – Exit sign using LEDS



Practical Applications – AC Regulator



Practical Applications – Square-Wave Generator