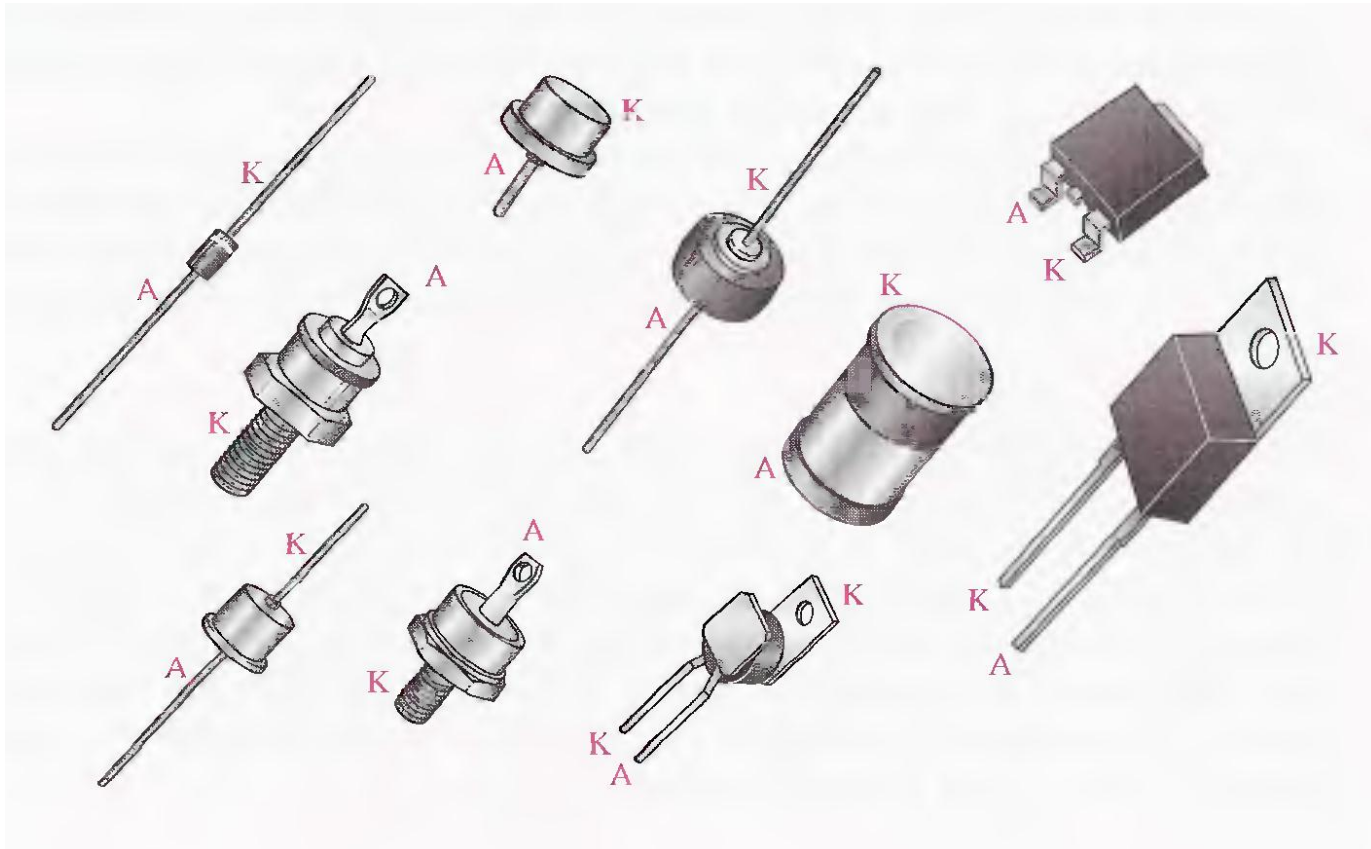




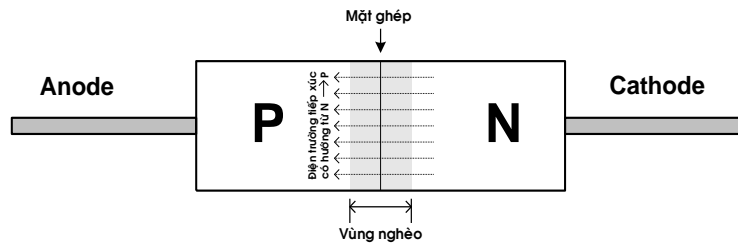
Chương 1:
LINH KIẾN BÁN DẪN 2 LỚP
VÀ ỨNG DỤNG (TT)

DIODE

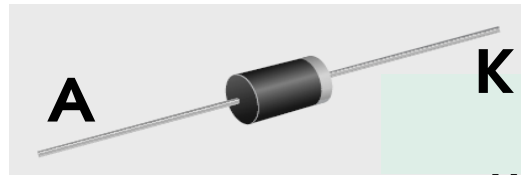
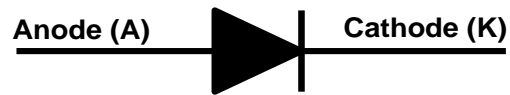


Diode chỉnh lưu

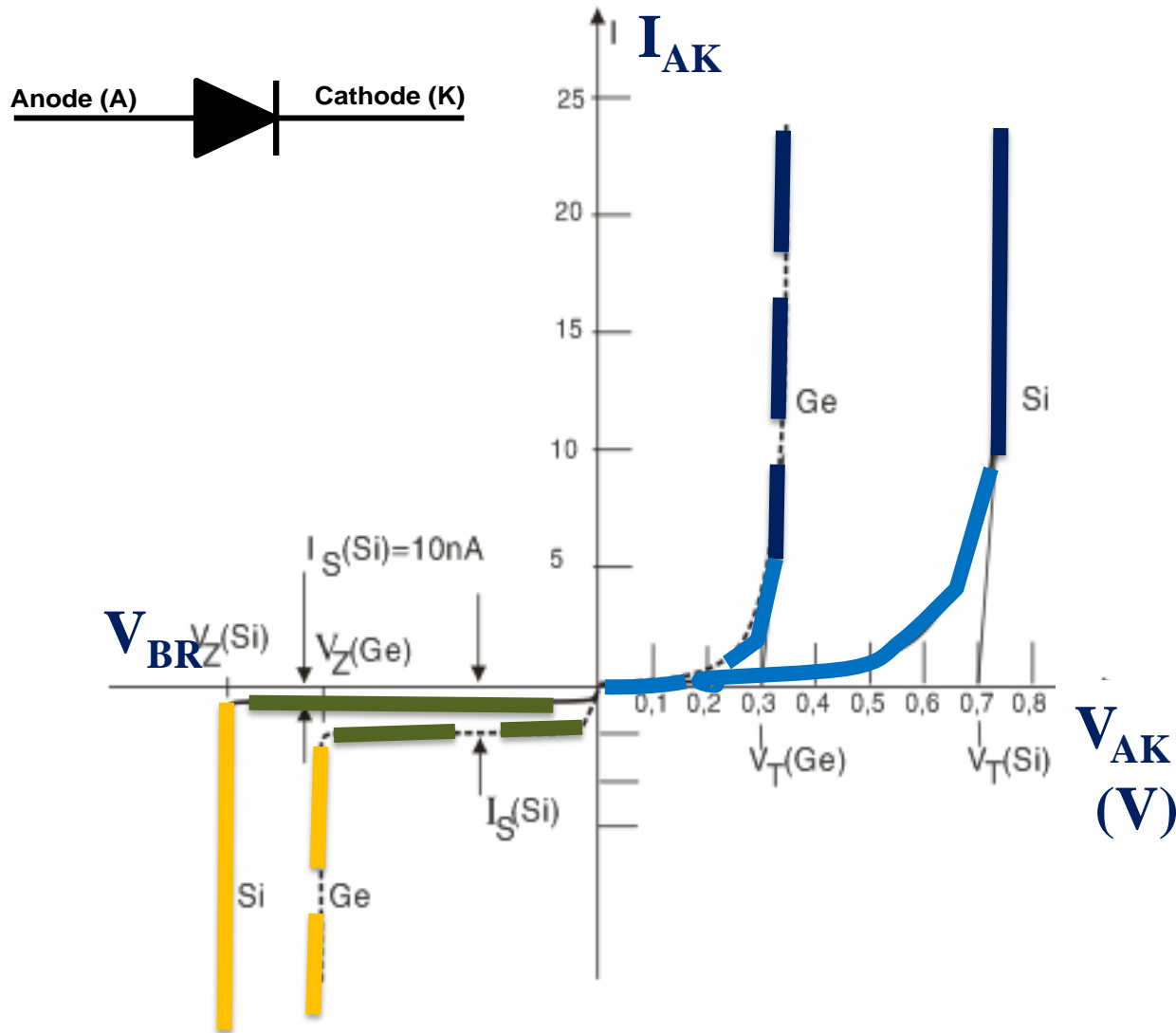
Cấu tạo



Symbol:



Đặc tuyến Volt Ampere

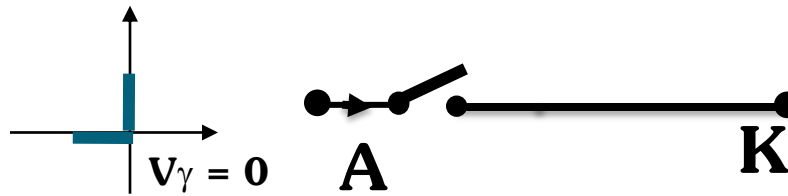


Vùng đánh thủng

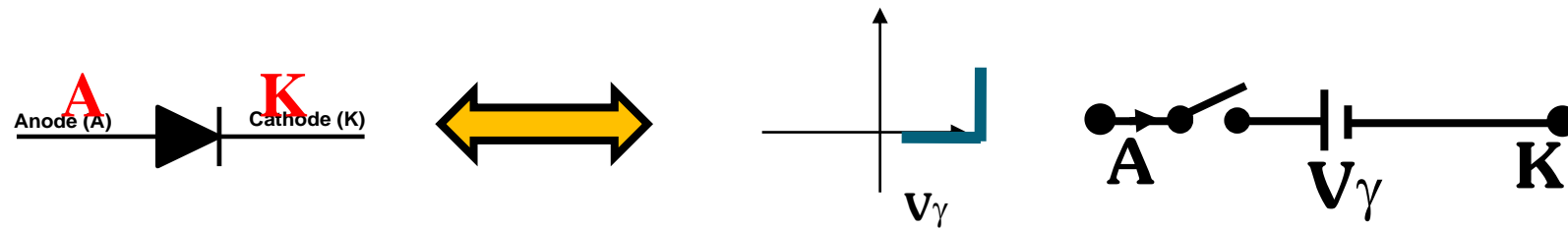
Vùng dẫn $V_{AK} > V_\gamma$

Vùng phân cực ngược

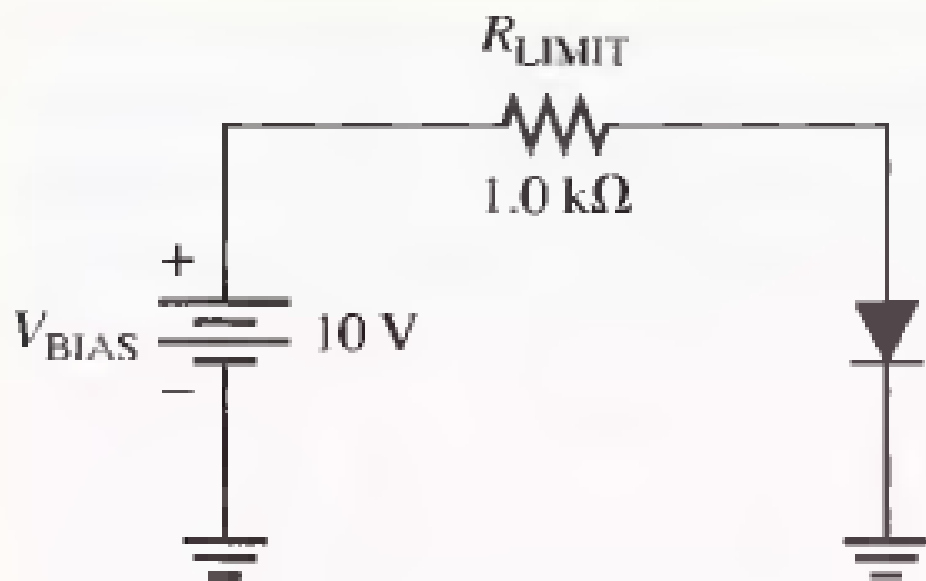
Models of Diode



Ideal Model $V_\gamma = 0$ (Diode lý tưởng)



Practical Model (Sụt áp là hằng số)



Ideal model:

$$V_F = \mathbf{0\ V}$$

$$I_F = \frac{V_{\text{BIAS}}}{R_{\text{LIMIT}}} = \frac{10\ \text{V}}{1.0\ \text{k}\Omega} = \mathbf{10\ \text{mA}}$$

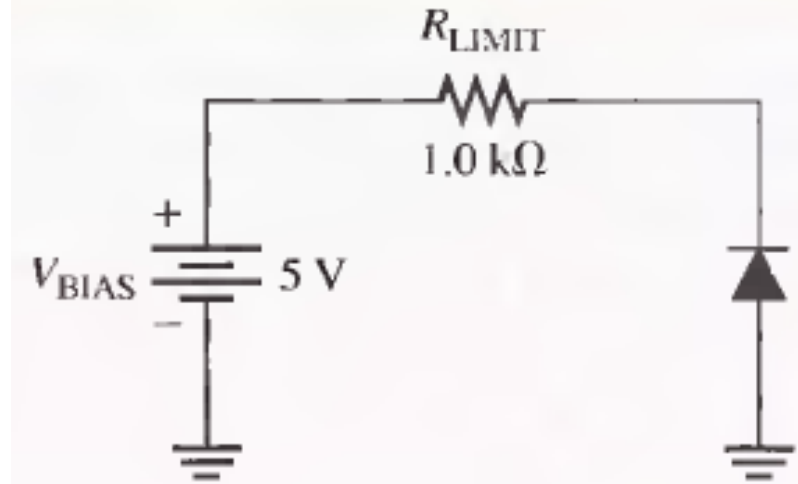
Practical model:

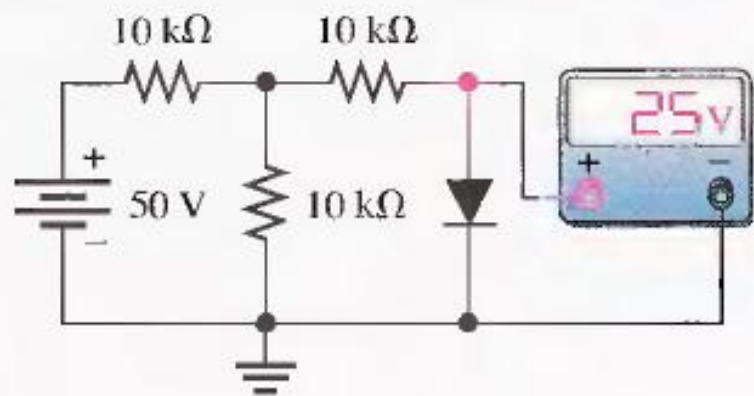
$$V_F = \mathbf{0.7\ V}$$

$$I_F = \frac{V_{\text{BIAS}} - V_F}{R_{\text{LIMIT}}} = \frac{10\ \text{V} - 0.7\ \text{V}}{1.0\ \text{k}\Omega} = \frac{9.3\ \text{V}}{1.0\ \text{k}\Omega} = \mathbf{9.3\ \text{mA}}$$

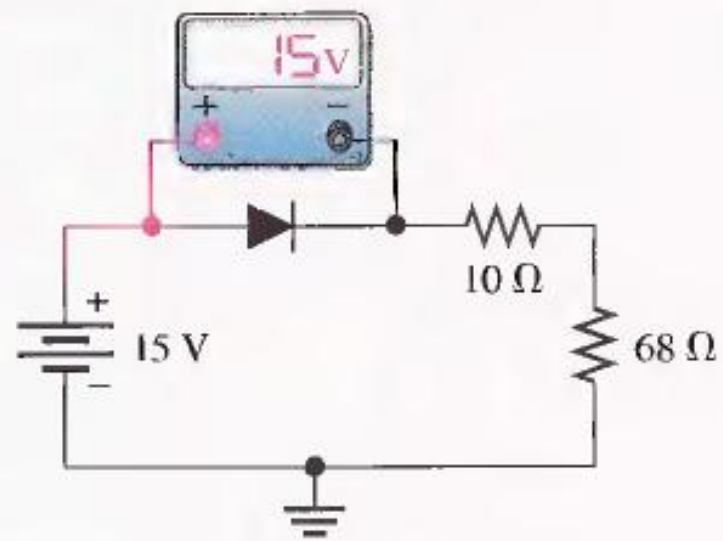
$$V_{R_{\text{LIMIT}}} = I_F R_{\text{LIMIT}} = (9.3\ \text{mA})(1.0\ \text{k}\Omega) = \mathbf{9.3\ V}$$

Reverse bias : $I_R = 0$

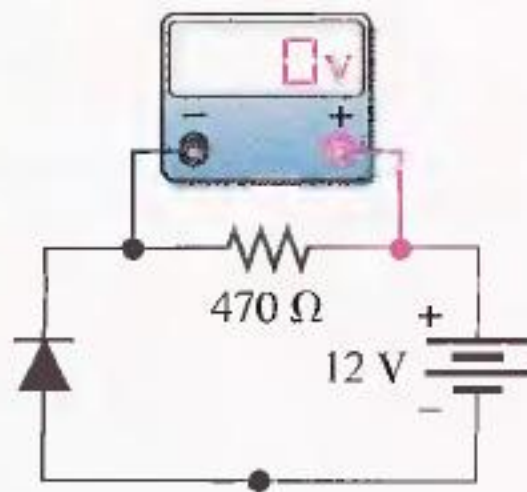
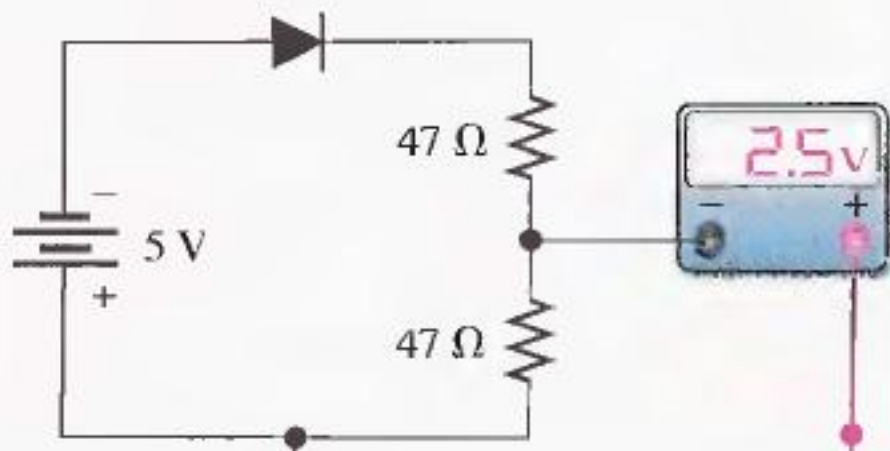




(a)



(b)



Axial Lead Standard Recovery Rectifiers

This data sheet provides information on subminiature size, axial lead mounted rectifiers for general-purpose low-power applications.

Mechanical Characteristics

- Case: Epoxy, Molded
- Weight: 0.4 gram (approximately)
- Finish: All External Surfaces Corrosion Resistant and Terminal Leads are Readily Solderable
- Lead and Mounting Surface Temperature for Soldering Purposes: 220°C Max. for 10 Seconds, 1/16" from case
- Shipped in plastic bags, 1000 per bag.
- Available Tape and Reeled, 5000 per reel, by adding a "RL" suffix to the part number
- Polarity: Cathode Indicated by Polarity Band
- Marking: 1N4001, 1N4002, 1N4003, 1N4004, 1N4005, 1N4006, 1N4007

**1N4001
thru
1N4007**

1N4004 and 1N4007 are
Motorola Preferred Devices

**LEAD MOUNTED
RECTIFIERS
50-1000 VOLTS
DIFFUSED JUNCTION**



CASE 59-03
DO-41

MAXIMUM RATINGS

Rating	Symbol	1N4001	1N4002	1N4003	1N4004	1N4005	1N4006	1N4007
*Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000
*Non-Repetitive Peak Reverse Voltage (halfwave, single phase, 60 Hz)	V_{RSM}	60	120	240	480	720	1000	1200
*RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700
*Average Rectified Forward Current (single phase, resistive load, 60 Hz, see Figure 8, $T_A = 75^\circ\text{C}$)	I_O	1.0						
*Non-Repetitive Peak Surge Current (surge applied at rated load conditions, see Figure 2)	I_{FSM}	30 (for 1 cycle)						
Operating and Storage Junction Temperature Range	T_J T_{stg}	– 65 to +175						

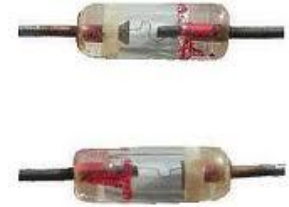
ELECTRICAL CHARACTERISTICS*

Rating	Symbol	Typ	Max
Maximum Instantaneous Forward Voltage Drop ($i_F = 1.0$ Amp, $T_J = 25^\circ\text{C}$) Figure 1	v_F	0.93	1.1
Maximum Full-Cycle Average Forward Voltage Drop ($I_O = 1.0$ Amp, $T_L = 75^\circ\text{C}$, 1 inch leads)	$V_{F(AV)}$	—	0.8
Maximum Reverse Current (rated dc voltage) ($T_J = 25^\circ\text{C}$) ($T_J = 100^\circ\text{C}$)	I_R	0.05 1.0	10 50
Maximum Full-Cycle Average Reverse Current ($I_O = 1.0$ Amp, $T_L = 75^\circ\text{C}$, 1 inch leads)	$I_{R(AV)}$	—	30

CÁC LOẠI DIODE

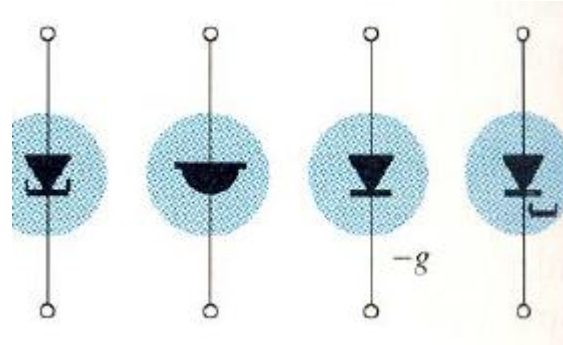


Diode tách sóng : sử dụng tiếp xúc điểm để điện dung bé \rightarrow làm việc ở tần số cao

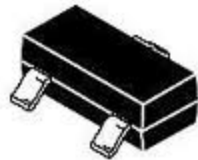
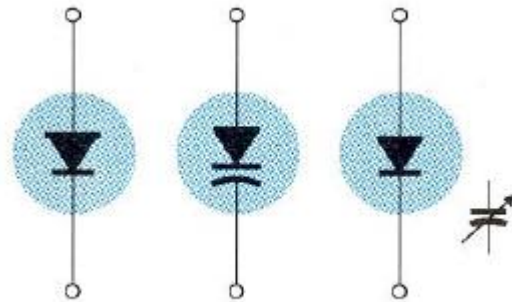


Oddbix.com

Diode tunnel : nồng độ tạp chất rất cao \rightarrow ứng dụng trong các mạch siêu cao tần



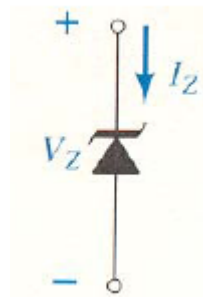
Diode biến dung : có lớp tiếp xúc đặc biệt để điện dung khá tuyến tính với điện áp ngược \rightarrow tạo sóng điều tần để điều chỉnh tần số cộng hưởng



Diode Schottky : tiếp xúc Schottky (bán dẫn, kim loại) → ứng dụng cho những mạch cần tốc độ chuyển mạch cao











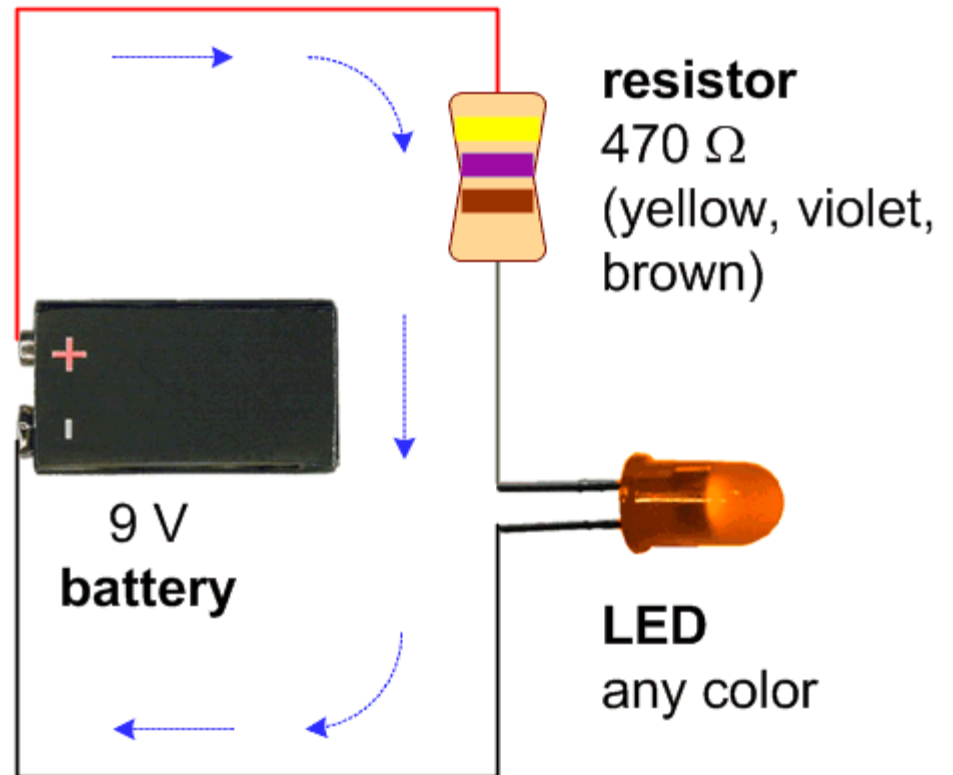
Diode Zener : thường bằng vật liệu Si chịu nhiệt và tỏa nhiệt tốt hoạt động chủ yếu vùng zener từ (1,8 ÷ 200)V

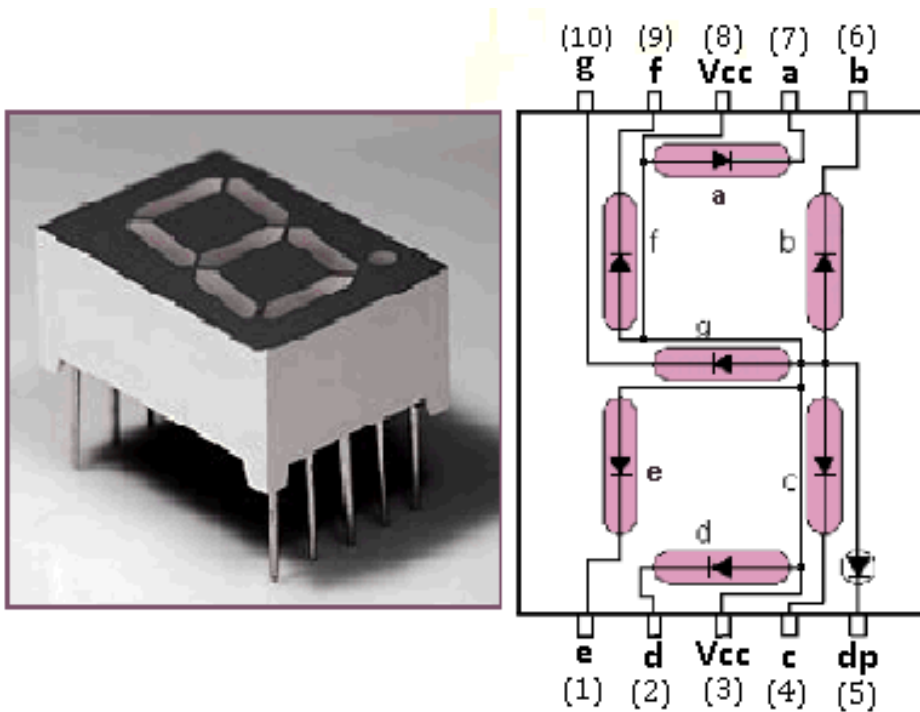
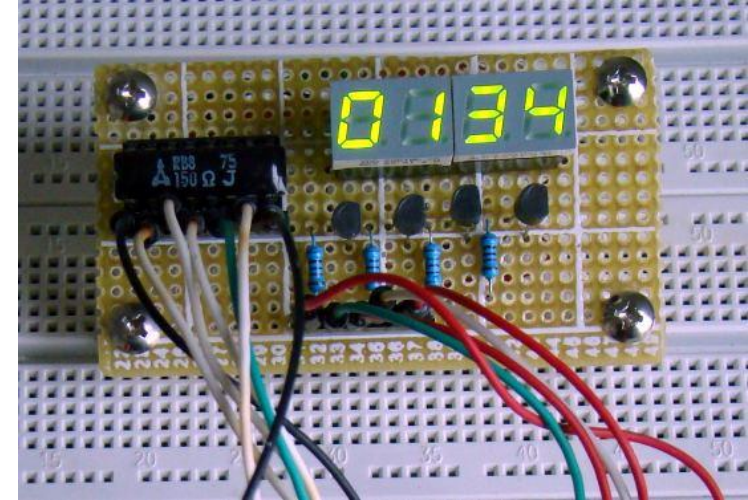


Diode phát quang : thường dùng bán dẫn hợp chất có mức Wg thay đổi điều chỉnh được theo nồng độ tạp chất, sử dụng yếu tố phát sáng bước sóng λ nhìn thấy được khi phân cực thuận có sự tái hợp e^- và lỗ trống

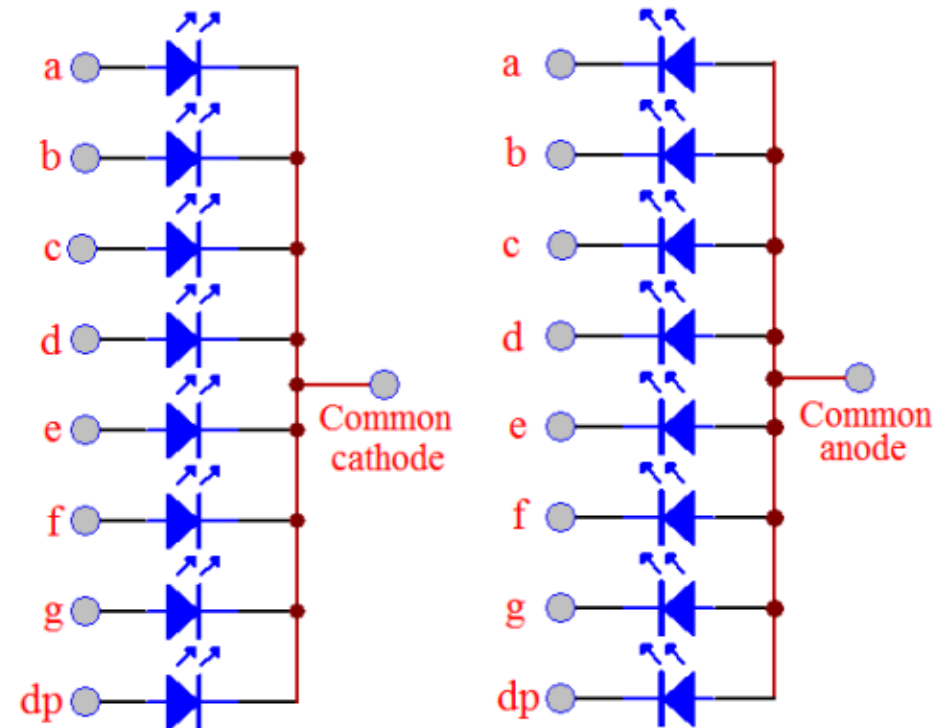


Color of LED	Voltage Drop (Volt)
 Red	1.63 ~ 2.03
 Yellow	2.10 ~ 2.18
 Orange	2.03 ~ 2.10
 Blue	2.48 ~ 3.7
 Green	1.9 ~ 4.0
 Violet	2.76 ~ 4.0
 UV	3.1 ~ 4.4
 White	3.2 to 3.6





Common Anode Mode

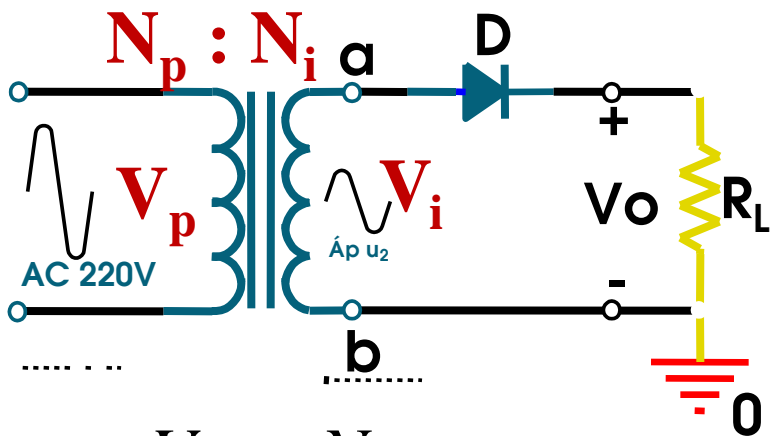


APPLICATIONS

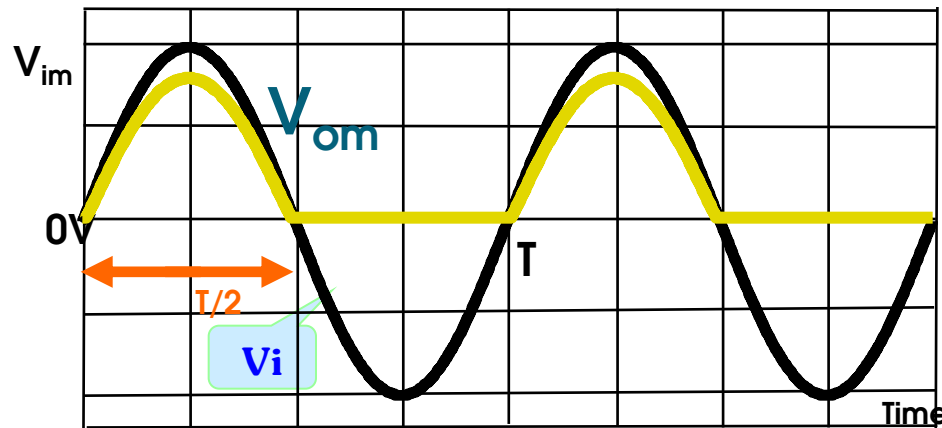


Chỉnh lưu - Rectifier(AC → DC)

a. Chỉnh lưu bán kỳ - Half Wave Rectifier



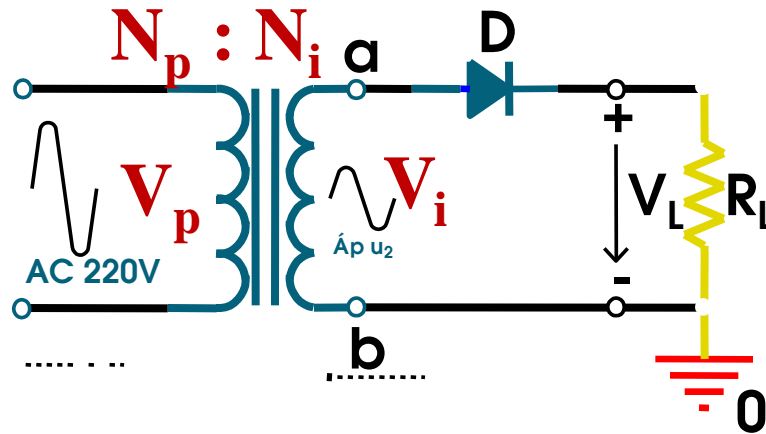
$$\frac{V_P}{V_i} = \frac{N_P}{N_i}$$



Điện áp trung bình ngõ ra

$$V_{ODC} = \frac{1}{T} \int_0^T V_o(t) dt = \frac{1}{2\pi} \int_0^\pi V_{Om} \sin(\omega t) d(\omega t) = \frac{V_{Om}}{\pi} = \frac{V_{im} - V_\gamma}{\pi}$$





Dòng trung bình qua tải

$$I_{ODC} = \frac{V_{ODC}}{R_L}$$

Dòng trung bình qua diode

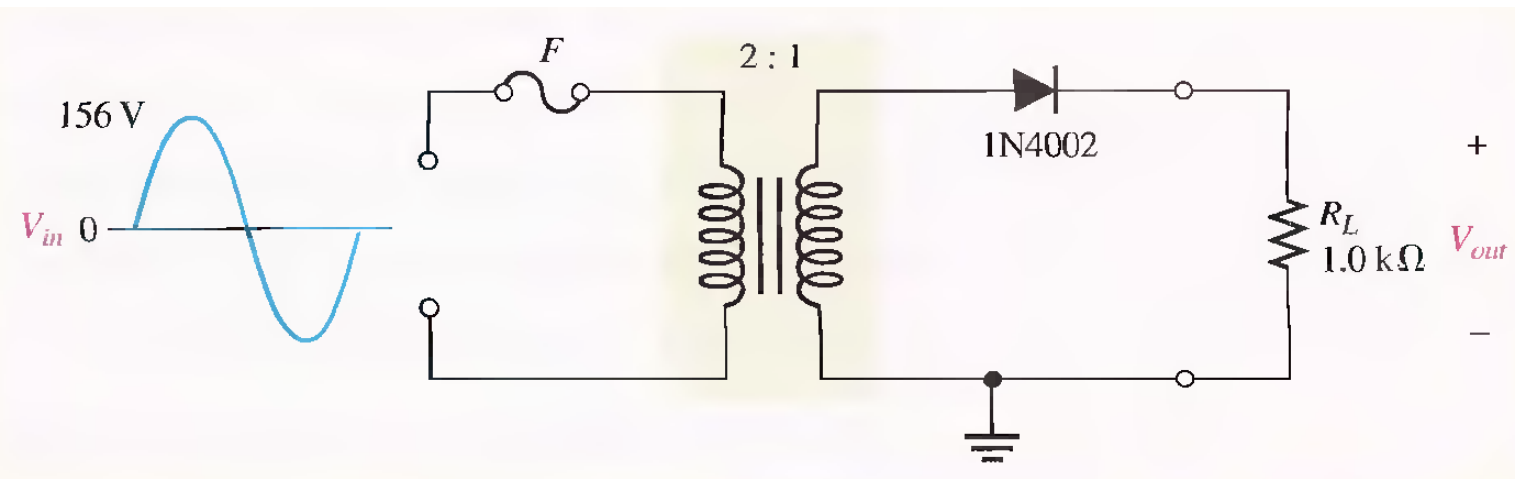
$$I_{DC_{DIODE}} = I_{ODC}$$

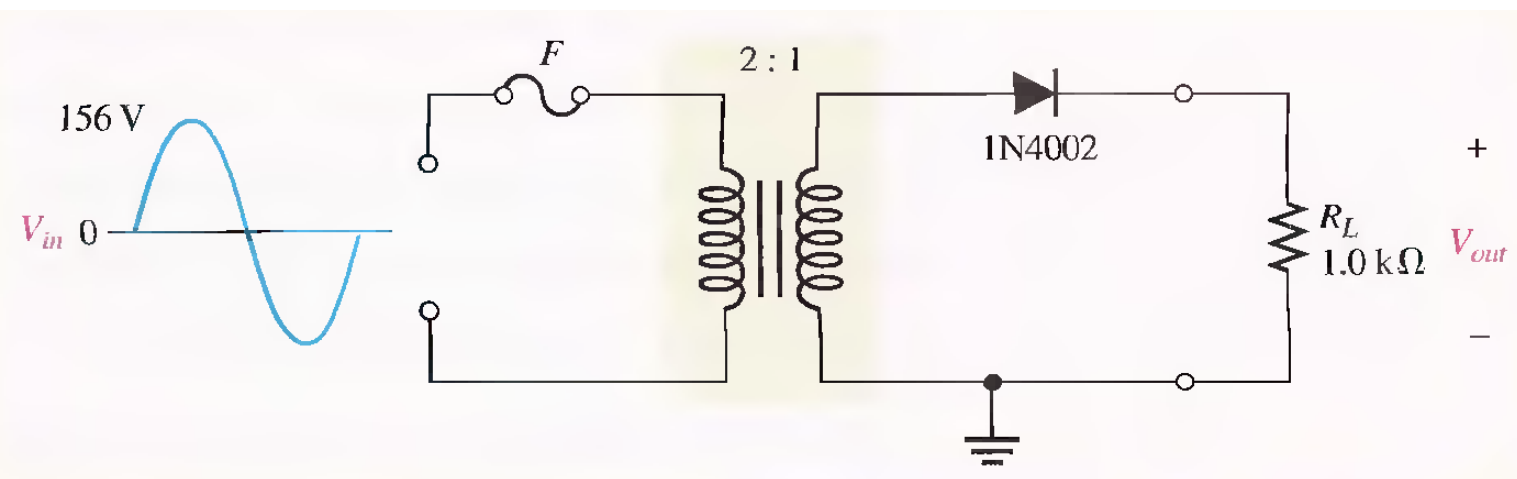
(PIV – Peak Inverse Voltage)

$$PIV = V_{im}$$

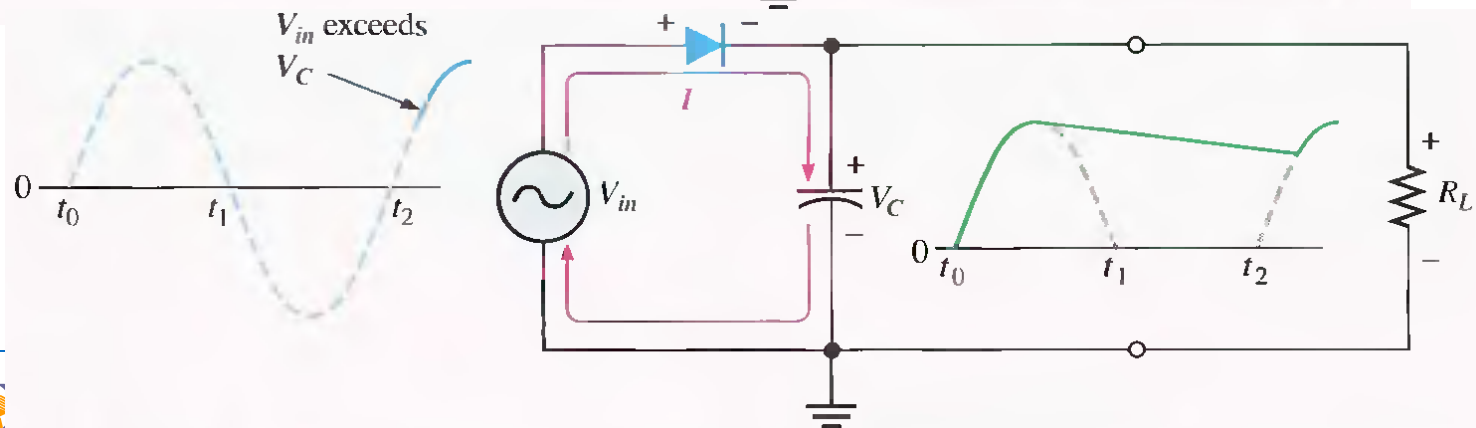
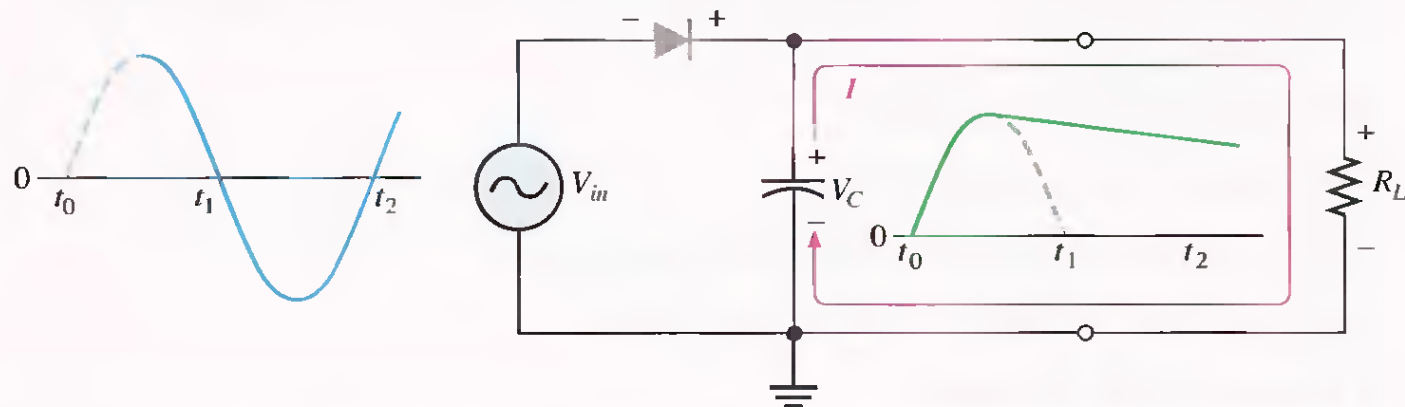
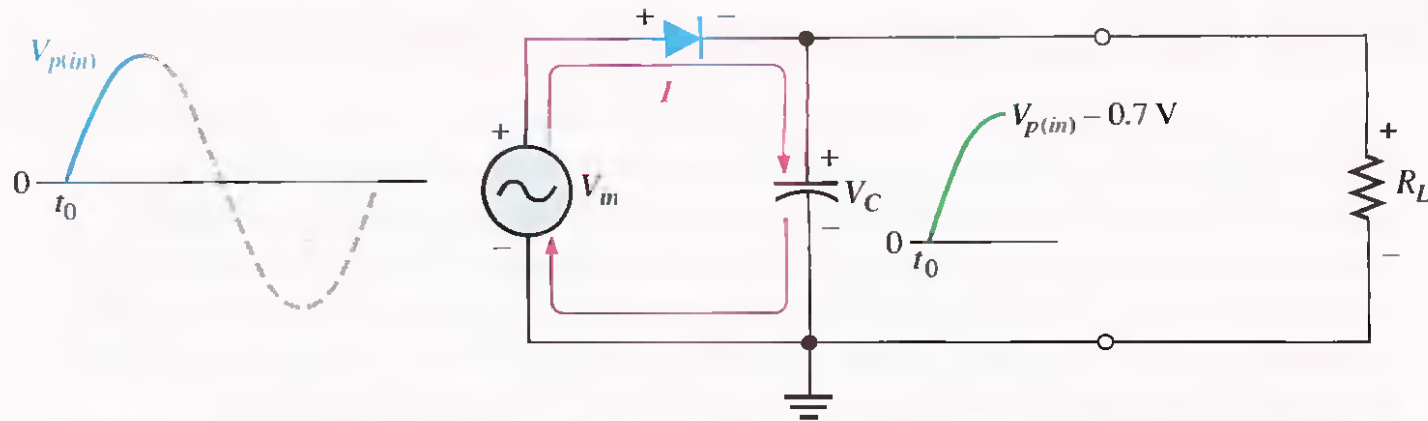


Vd:

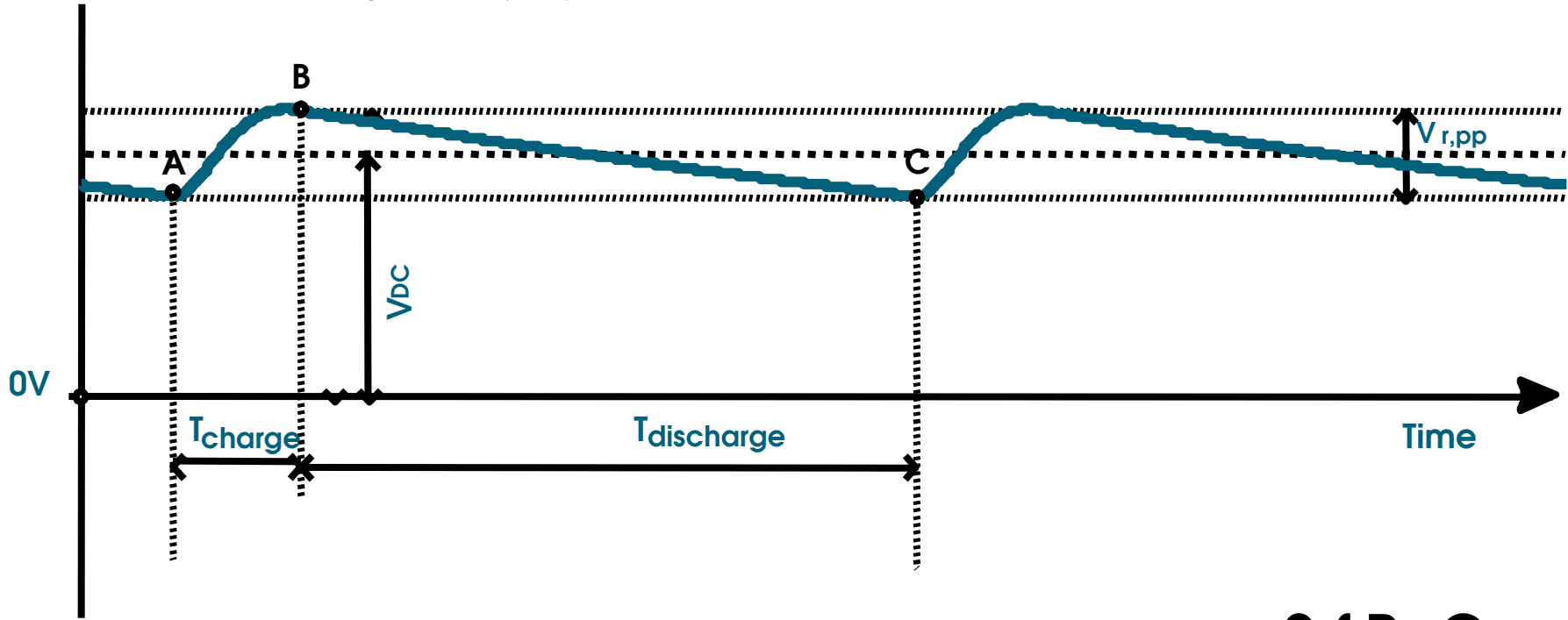




Chỉnh lưu bán kì có tụ lọc - Haft wave rectifier with capacitor - filter



Chỉnh lưu bán kỳ có tụ lọc - Haft wave rectifier with capacitor - filter



Điện áp trung bình trên tải

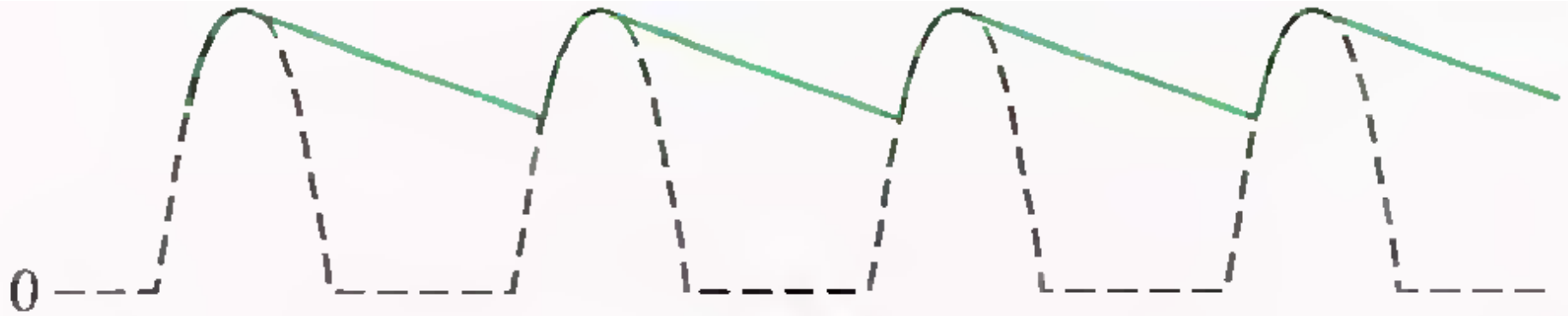
$$U_{ODC} = \frac{2.f.R_L.C}{1 + 2.f.R_L.C} . U_{Om}$$

Độ gợn sóng của điện áp trên tải

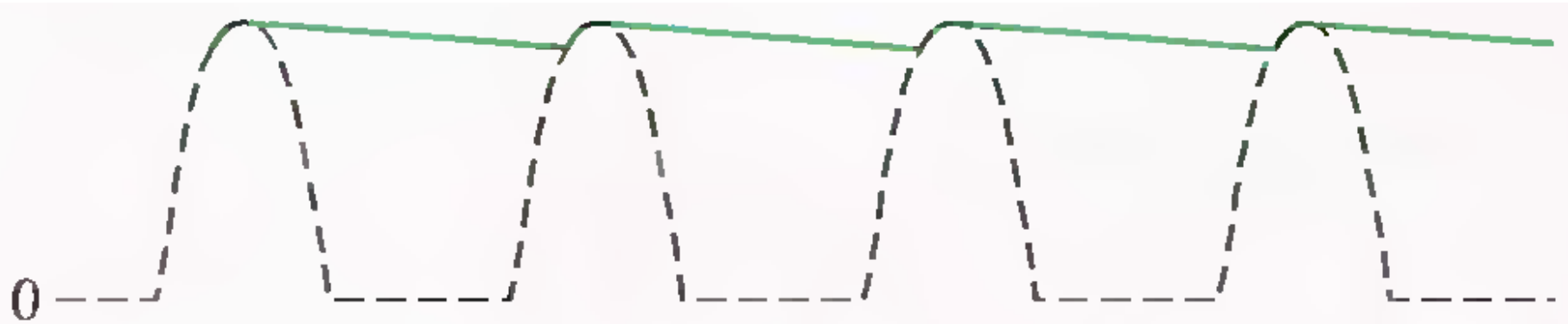
$$r\% = \frac{U_{r,rms}}{U_{ODC}} = \frac{100\%}{2\sqrt{3.f.R_L.C}}$$



Chỉ lưu bán kỳ có tụ lọc

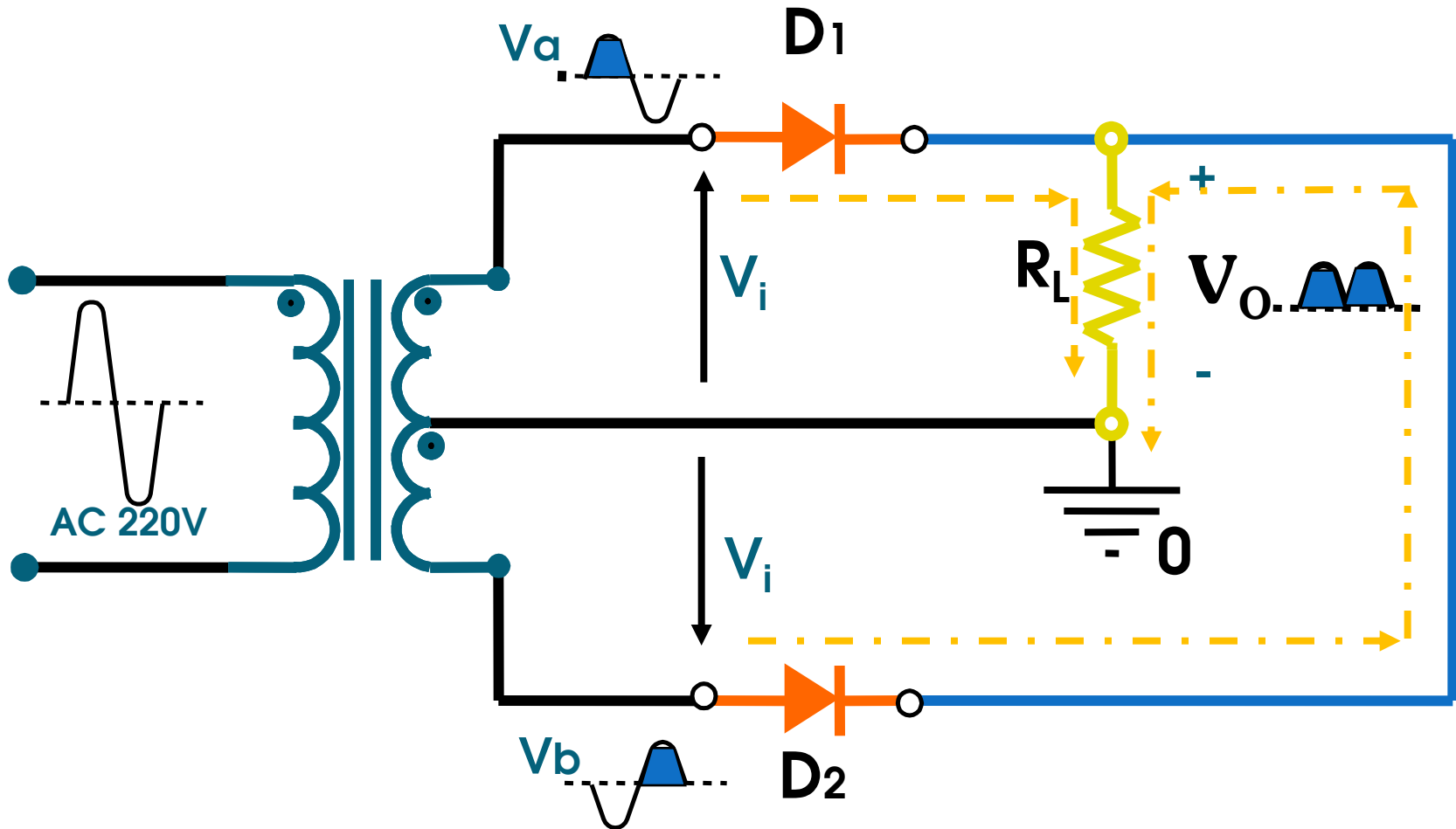


Tụ lọc có giá trị nhỏ \rightarrow độ gợn sóng lớn

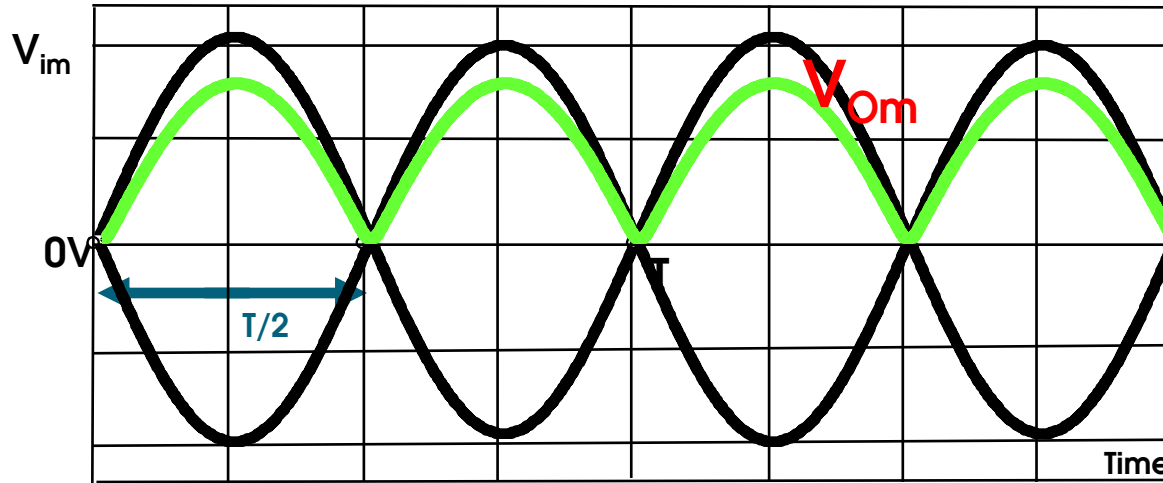


Tụ lọc có giá trị lớn \rightarrow độ gợn sóng nhỏ

Chỉnh lưu toàn kỳ dùng biến áp đôi - Full Wave Rectifier using center – tapped transformer



Chỉnh lưu toàn kỳ dùng biến áp đôi - Full Wave Rectifier using center – tapped tranformer

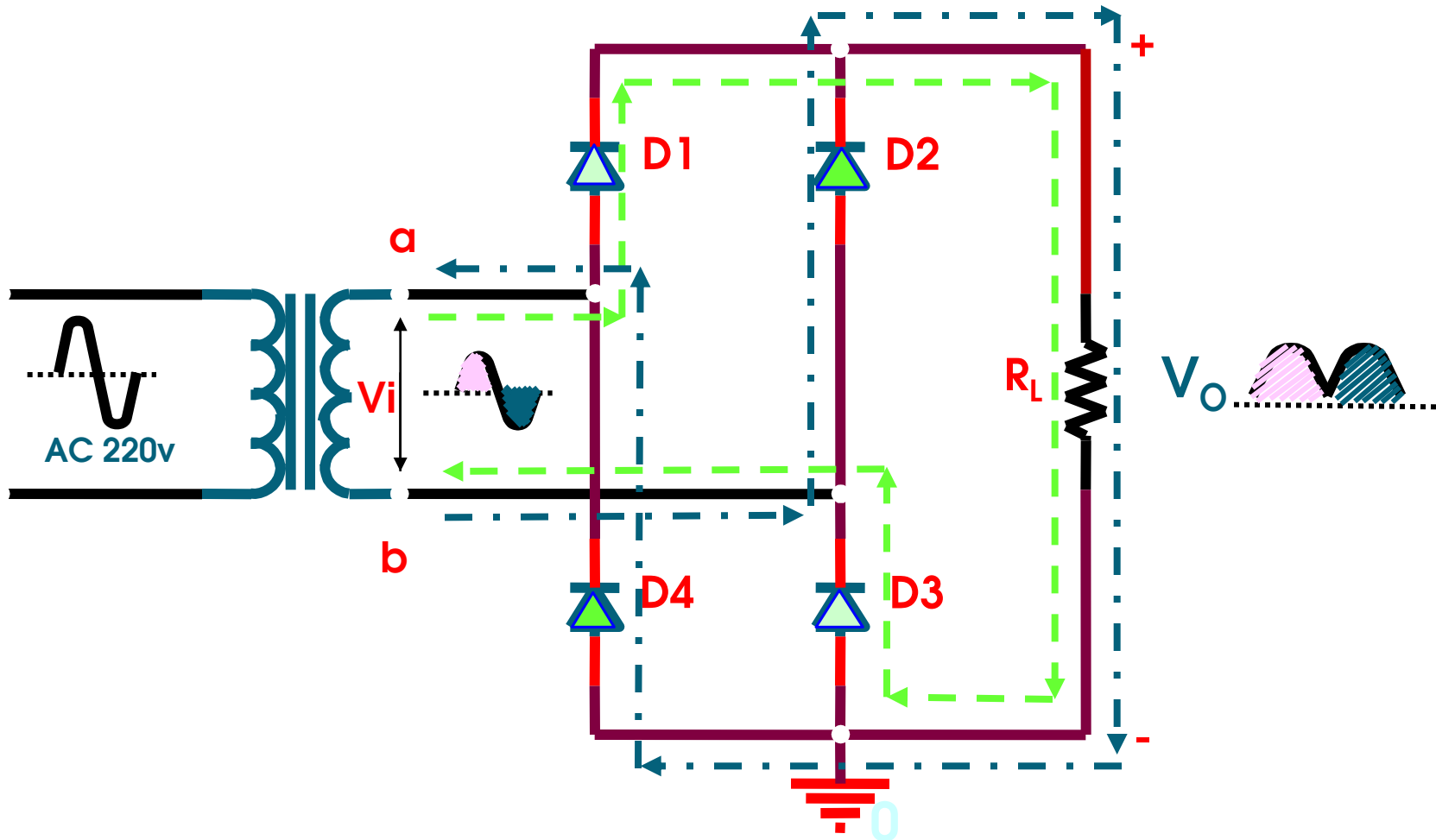


$$V_{ODC} = \frac{1}{T} \int_0^T V_O(t) dt = \frac{1}{2\pi} \int_0^{2\pi} V_{Om} \sin(\omega t) d(\omega t) = 2 \frac{V_{Om}}{\pi} = 2 \frac{V_i - V_\gamma}{\pi}$$

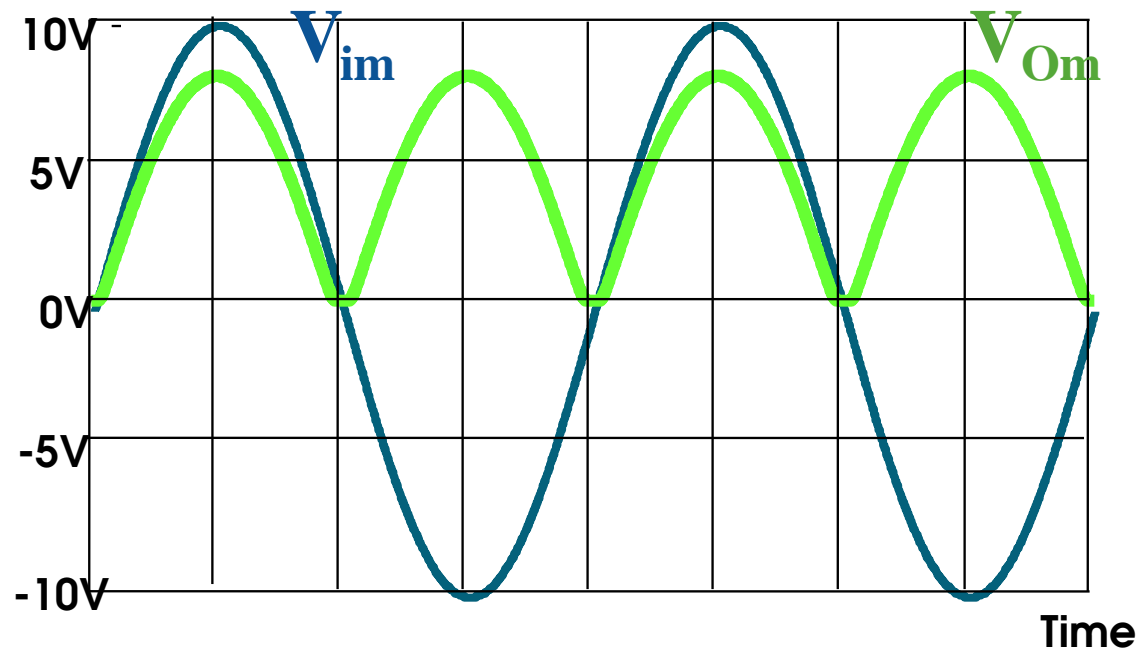
$$PIV = 2V_{im} - V_\gamma \quad I_{ODC} = \frac{V_{ODC}}{R_L} \quad I_{DC_{DIODE}} = \frac{I_{ODC}}{2}$$



c. Chỉnh lưu toàn kỳ dùng cầu diode - Full wave rectifier using diode bridge



c. Chỉnh lưu toàn kỳ dùng cầu diode - Full wave rectifier using diode bridge



$$V_{ODC} = 2 \frac{V_{Om}}{\pi} = 2 \frac{V_{im} - 2V_{\gamma}}{\pi}$$

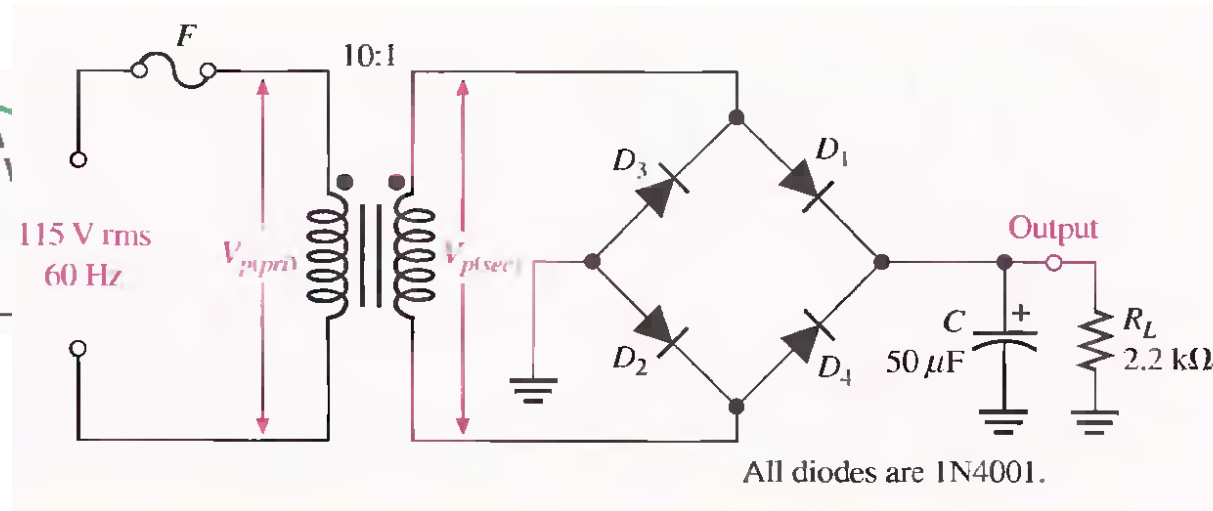
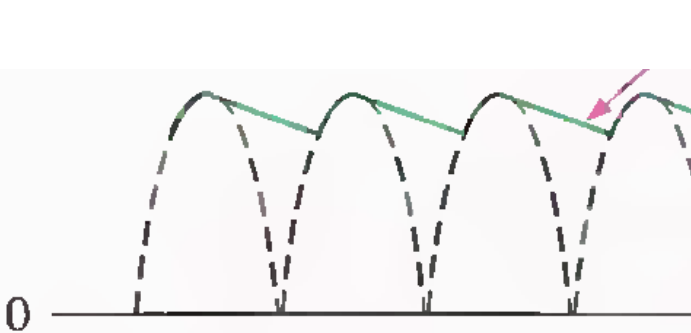
$$I_{DC_{DIODE}} = \frac{I_{ODC}}{2}$$

$$I_{ODC} = \frac{V_{ODC}}{R_L}$$

$$PIV = V_{im} - V_{\gamma}$$



Chỉnh lưu toàn kỳ có tụ lọc - Full wave rectifier with capacitor - filter



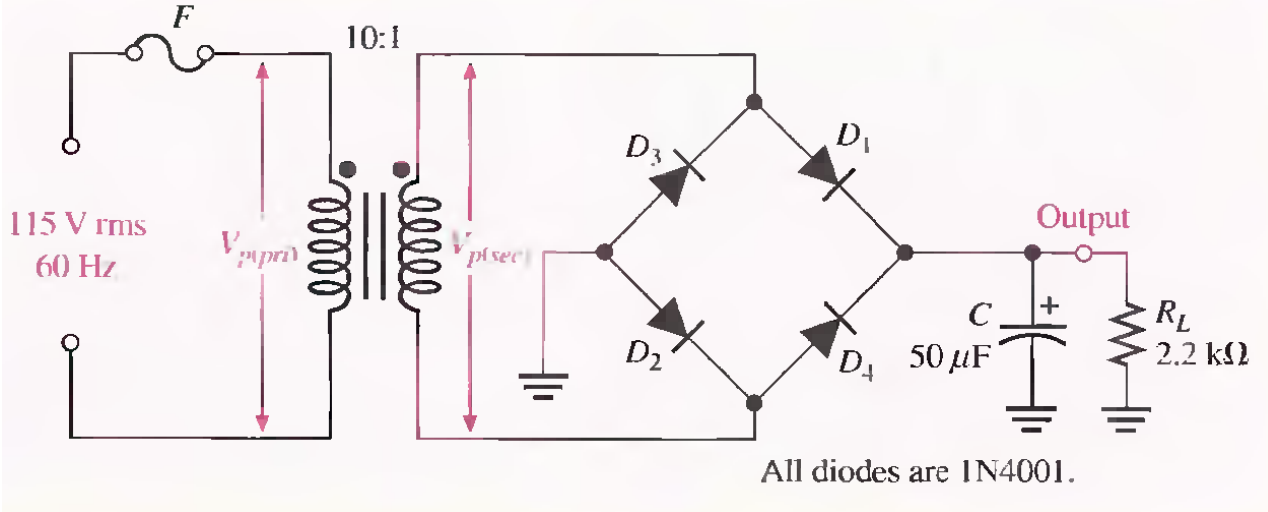
Điện áp trung bình trên tải

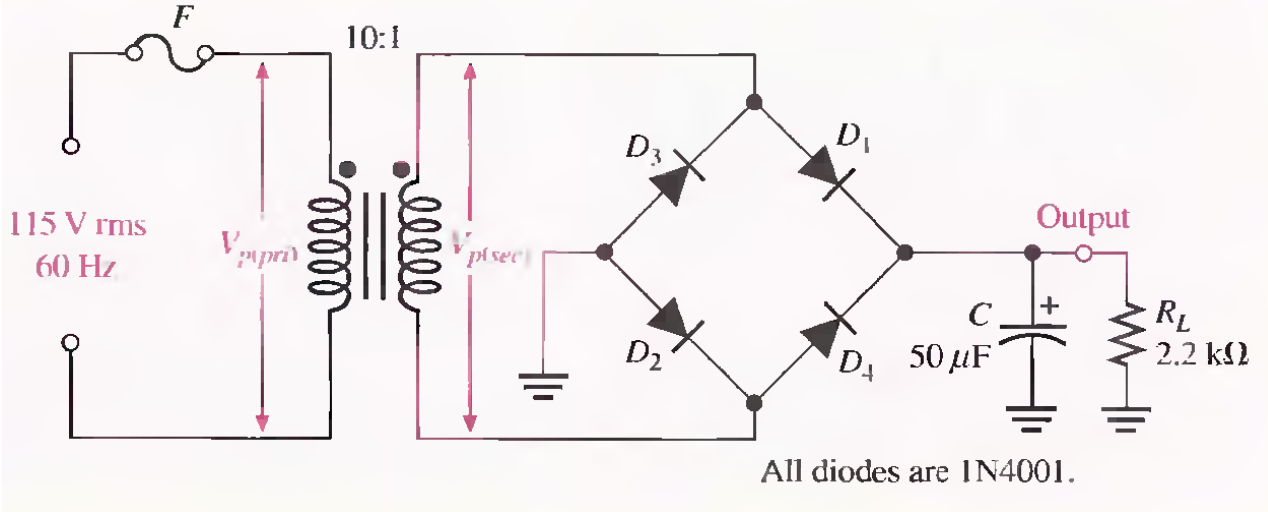
$$U_{ODC} = \frac{4 \cdot f \cdot R_L \cdot C}{1 + 4 \cdot f \cdot R_L \cdot C} \cdot U_{Om}$$

Độ gợn sóng của điện áp ngõ ra

$$r\% = \frac{U_{r,rms}}{U_{ODC}} = \frac{100\%}{4\sqrt{3} \cdot f \cdot R_L \cdot C}$$

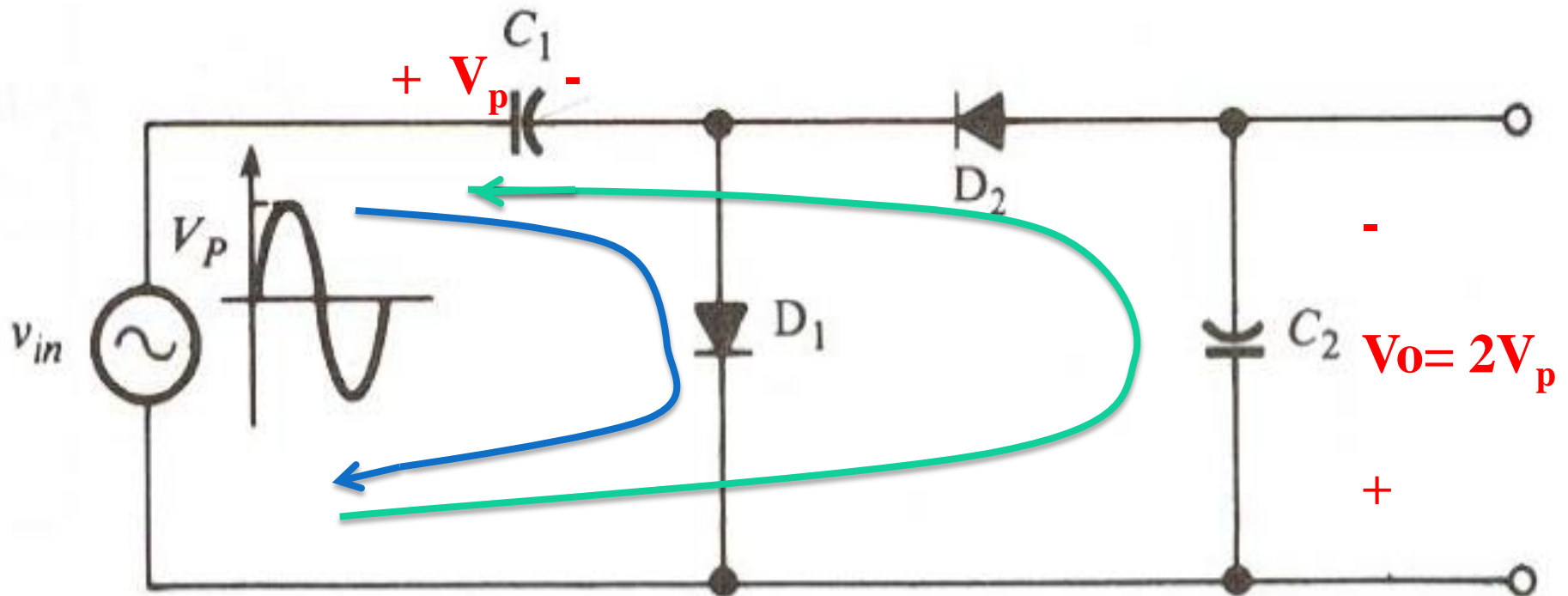




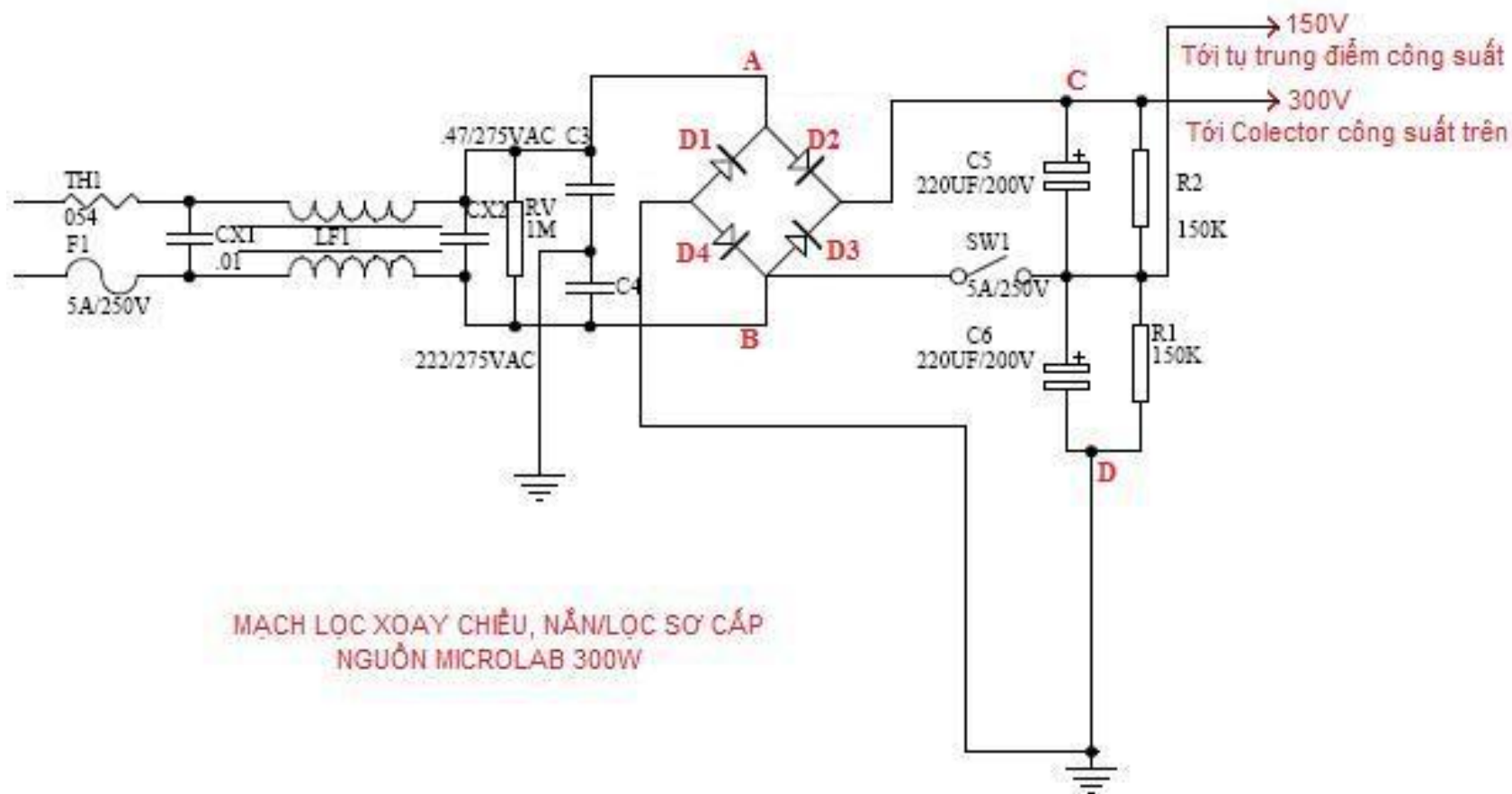


Mạch nhân áp

Mạch nhân áp bán kì

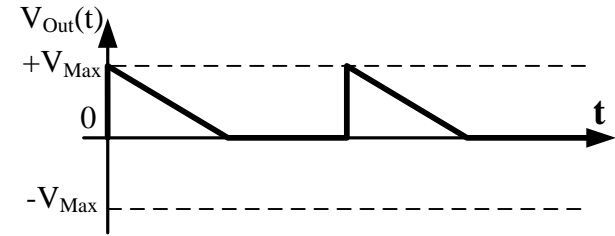
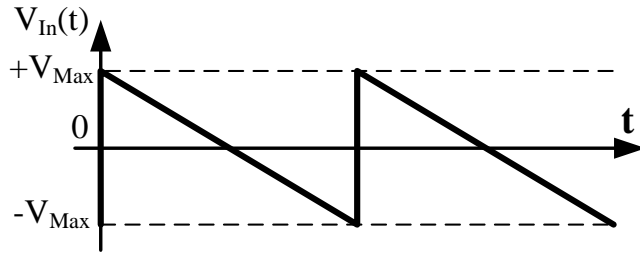
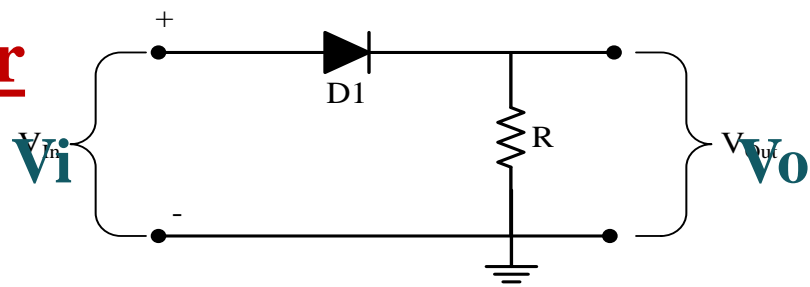


Ứng dụng



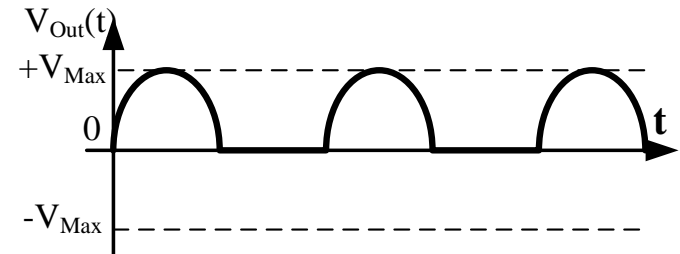
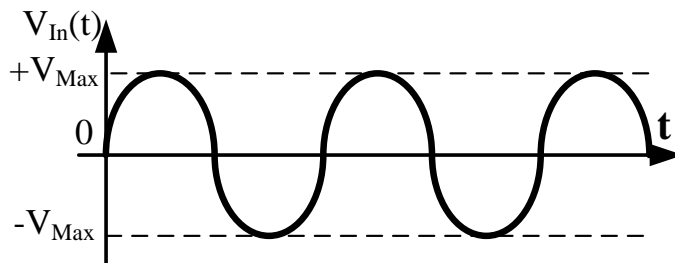
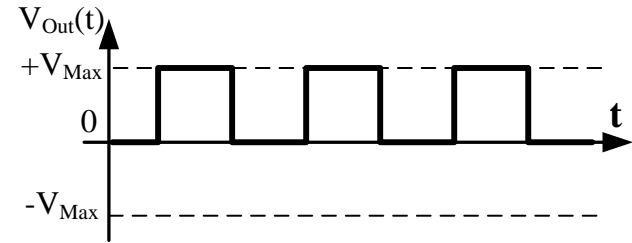
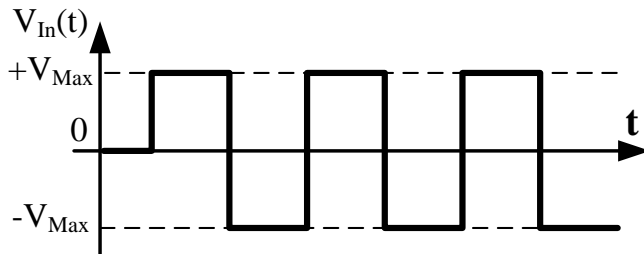
Mạch xén - Clipper

Mạch xén nối tiếp



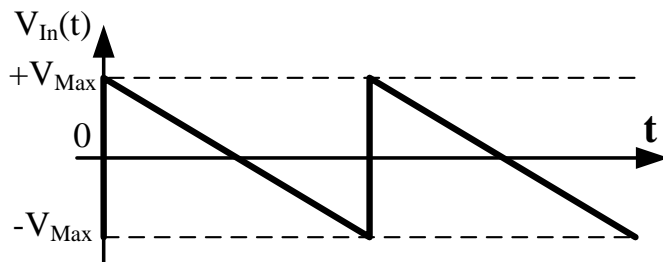
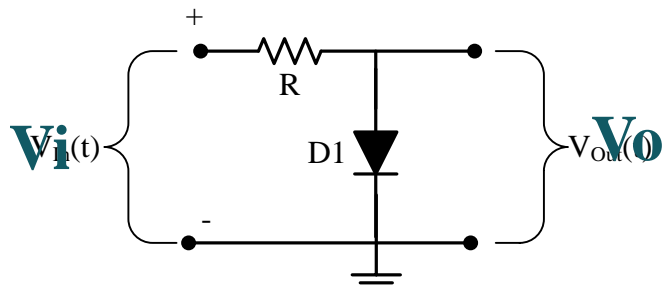
V_i

V_o

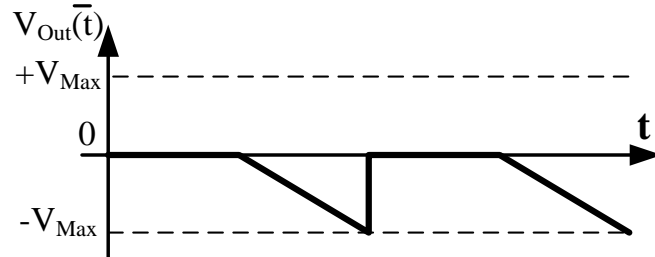


Mạch xén

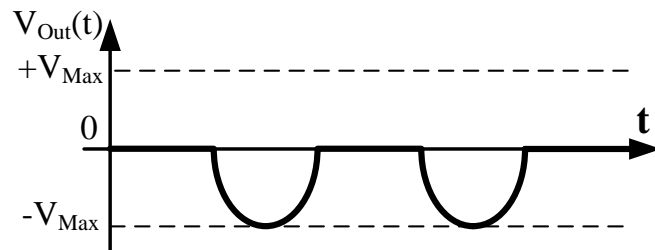
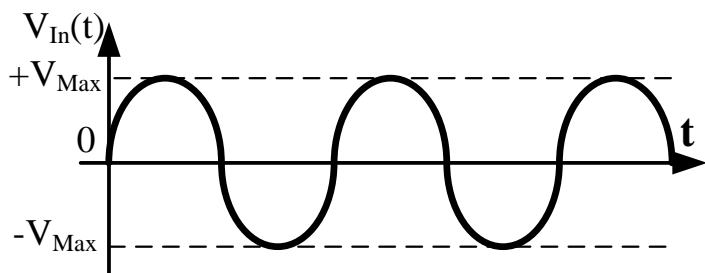
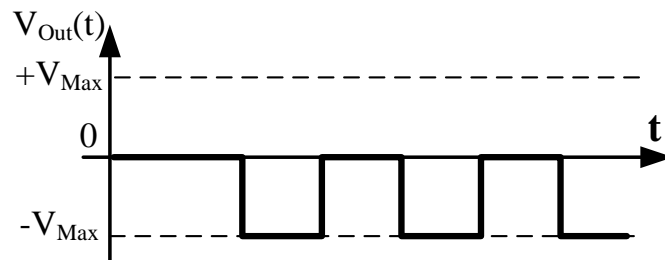
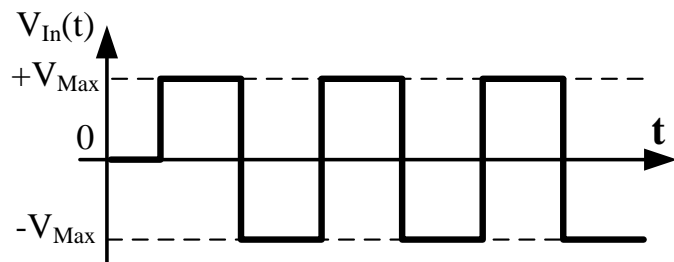
Mạch xén song song



V_i



V_o



Mạch xén (Clippers)

Các bước làm bài

- Tìm điều kiện của Vi để Diode dẫn (dùng định luật Kirchhoff)
- Tìm Vo tương ứng khi Diode dẫn.
- Tìm điều kiện Vi để Diode ngưng dẫn (ngược lại điều kiện dẫn)
- Tìm Vo tương ứng khi Diode không dẫn.
- Vẽ Vo

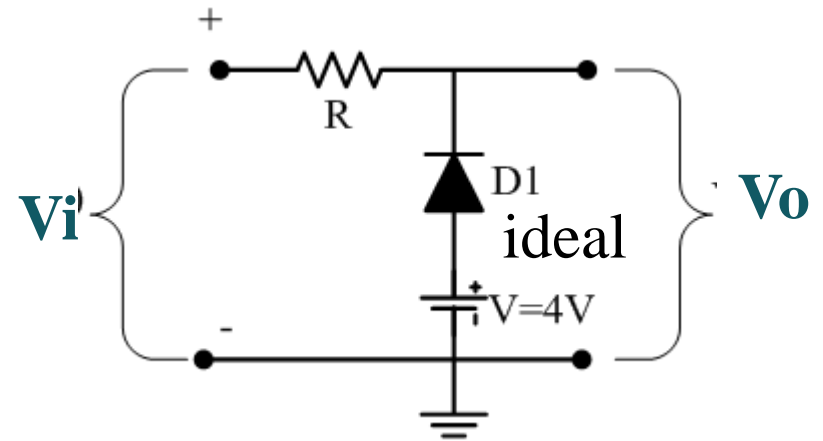
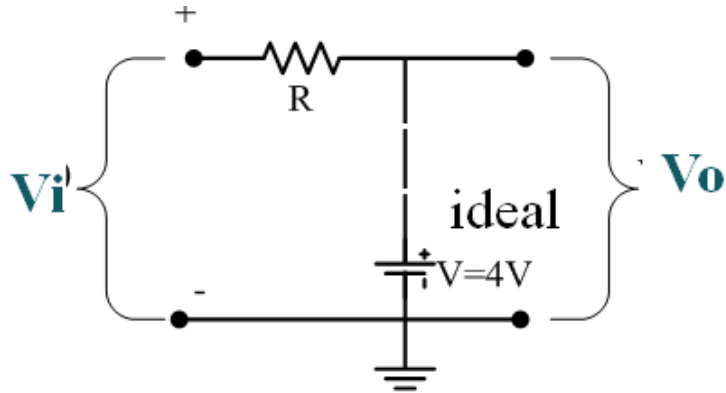


Mạch xén

Mạch xén song song

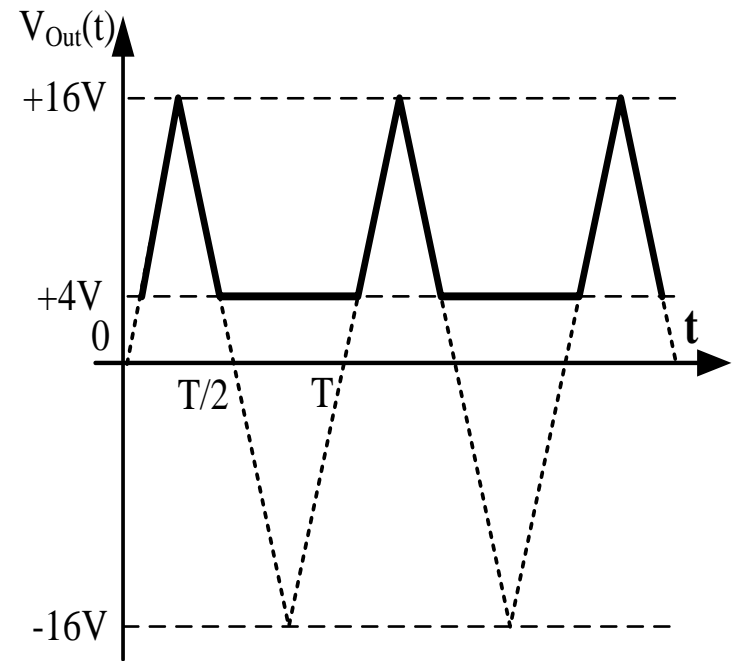
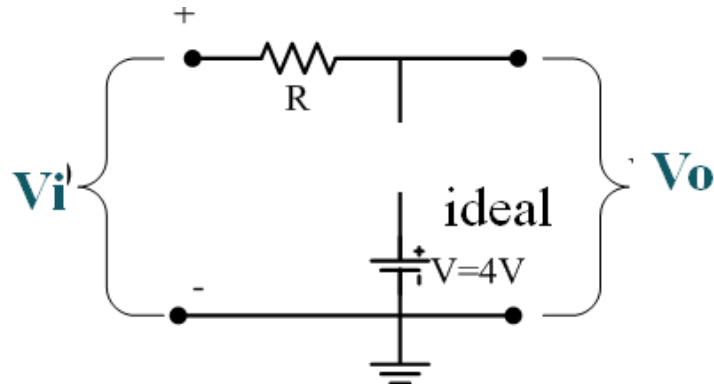
Điều kiện V_i để Diode dẫn $V_i \leq 4V$

Khi đó $V_o = 4V$



Diode không dẫn $V_i \geq 4V$

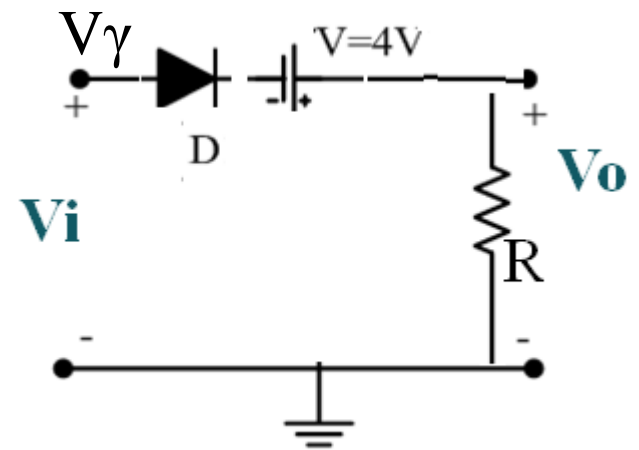
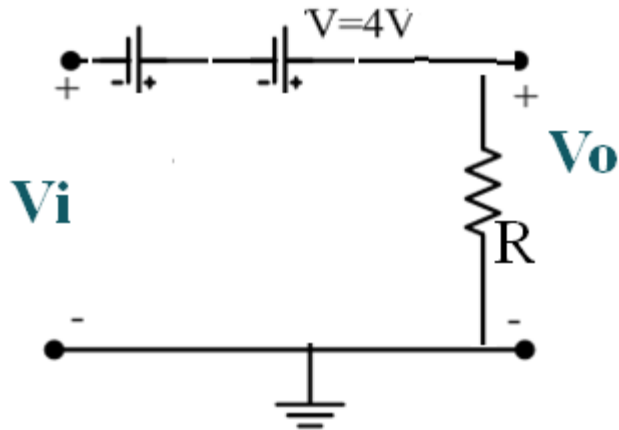
Khi đó $V_o = V_i$



Mạch xén nối tiếp

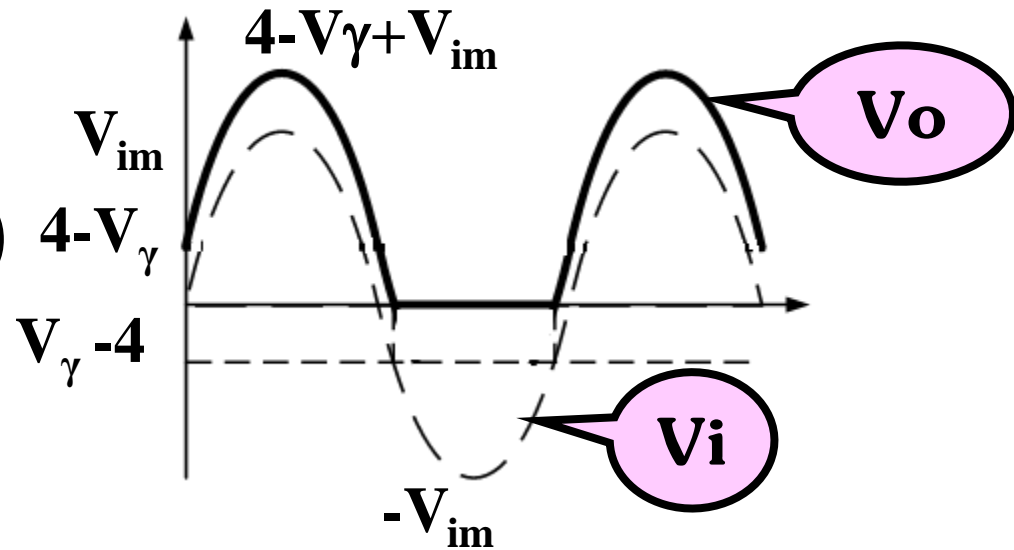
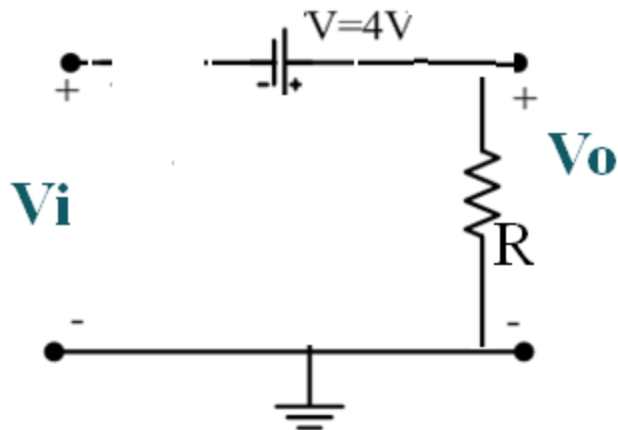
Diode dẫn khi: $V_i \geq (V_\gamma - 4)$

Khi đó $V_o = I.R_L = V_i + 4 - V_\gamma$

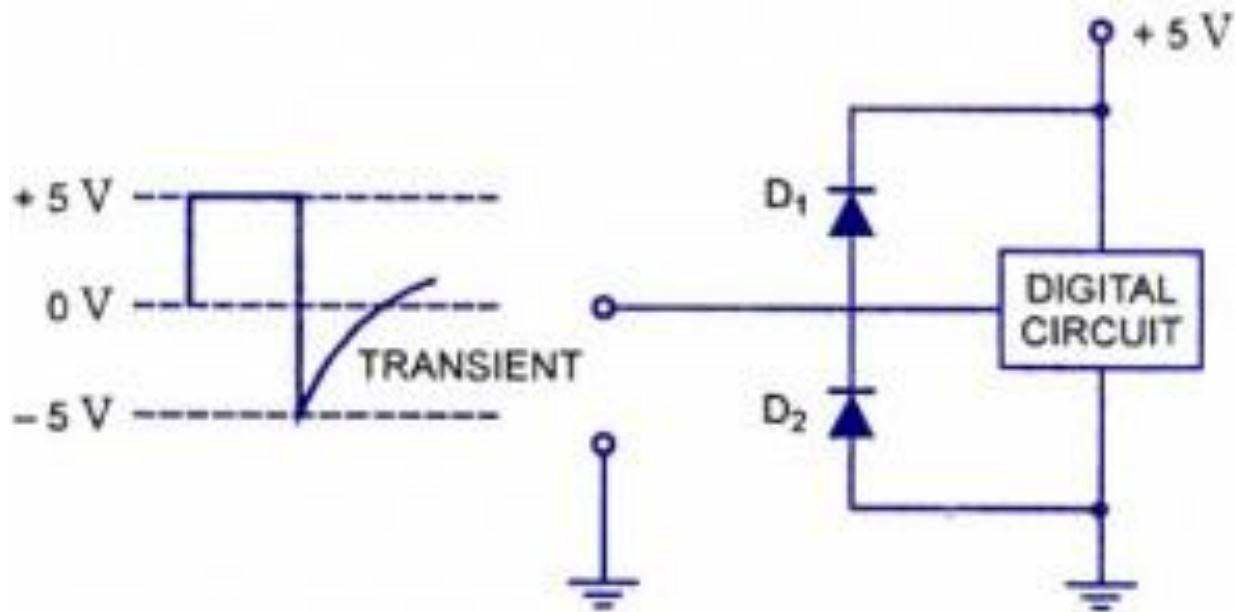


Diode không dẫn khi: $V_i \leq (4 + V_\gamma)$

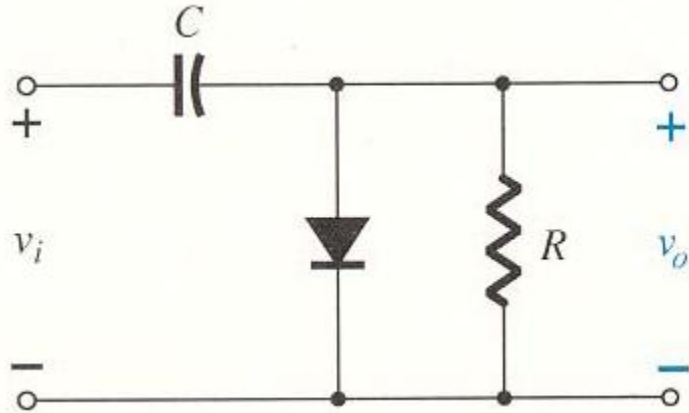
Khi đó $V_o = IR = 0$



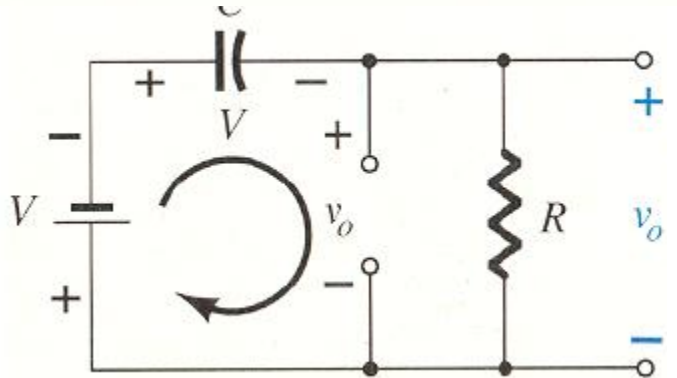
Ứng dụng mạch xén



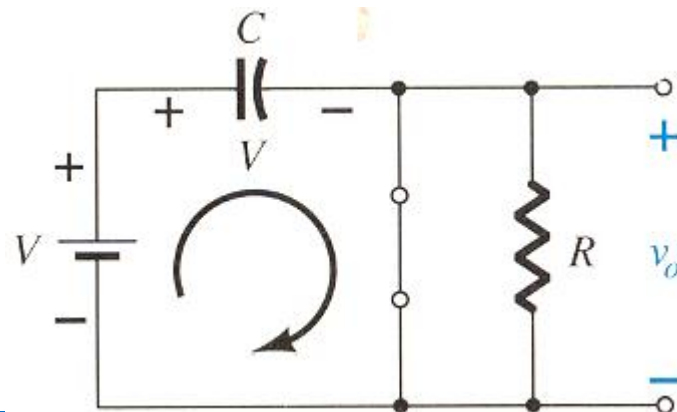
Mạch kẹp – Mạch dời mức DC (Clampers)



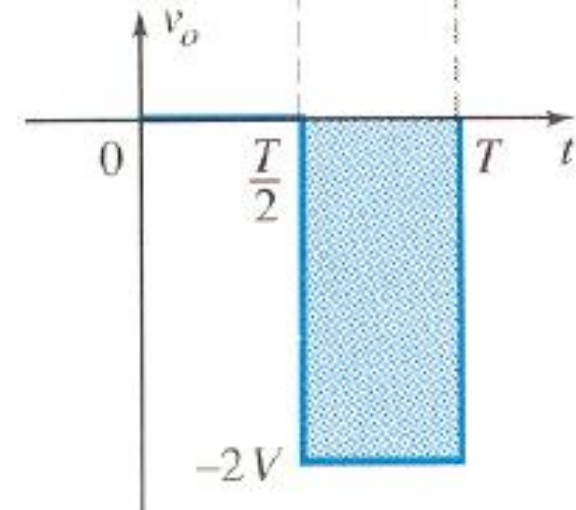
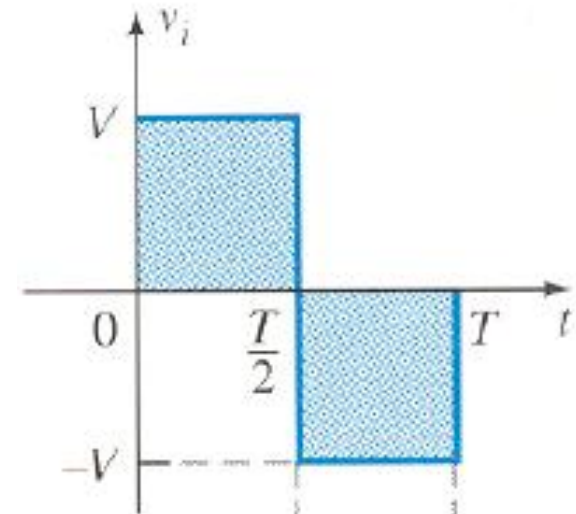
Mạch kẹp



Bán kì âm



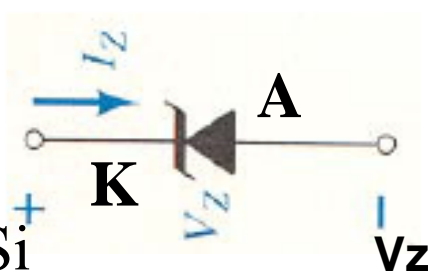
Bán kì dương



Diode zener

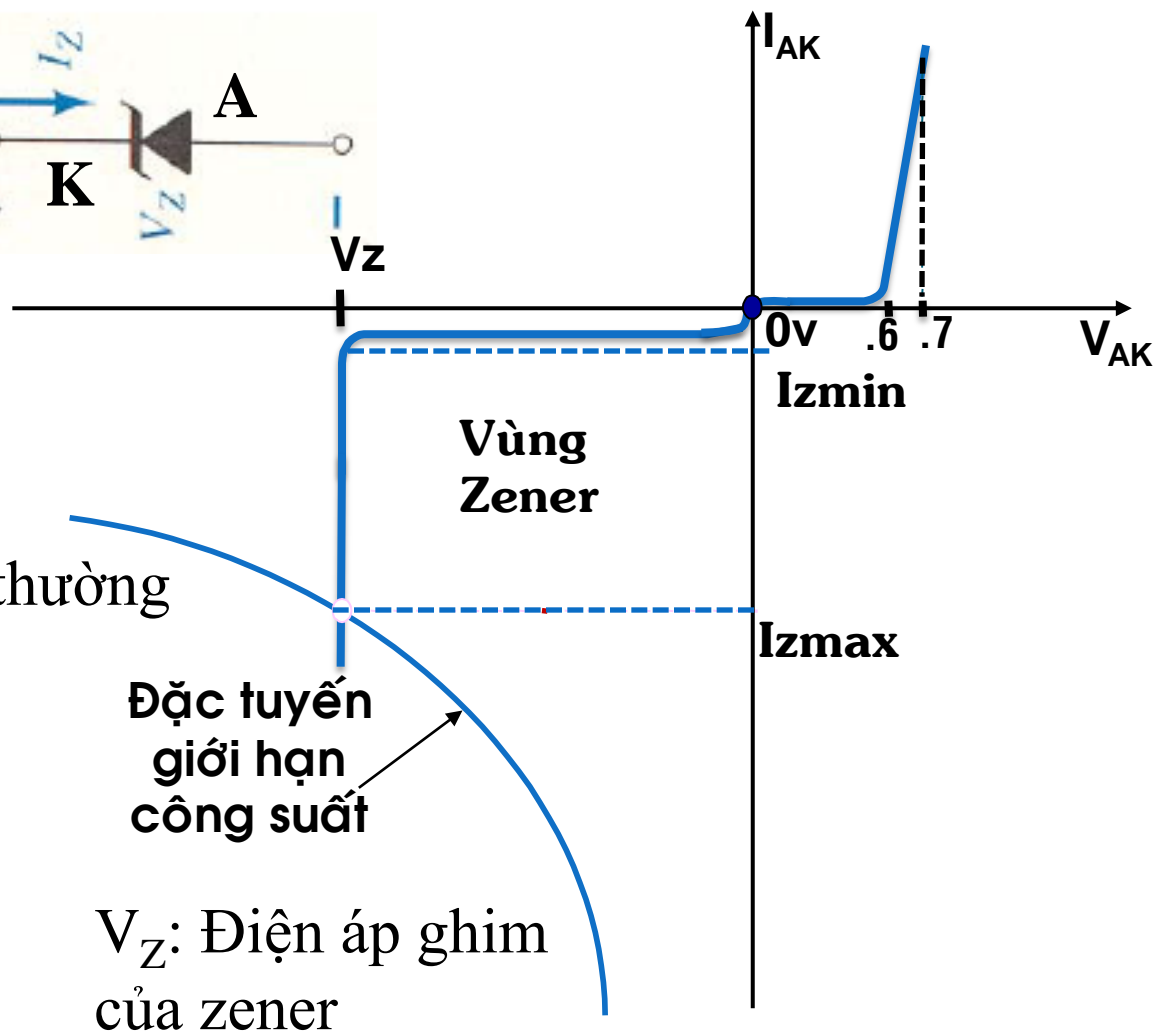
Cấu tạo

Thường cấu tạo bằng Si



Phân cực thuận:

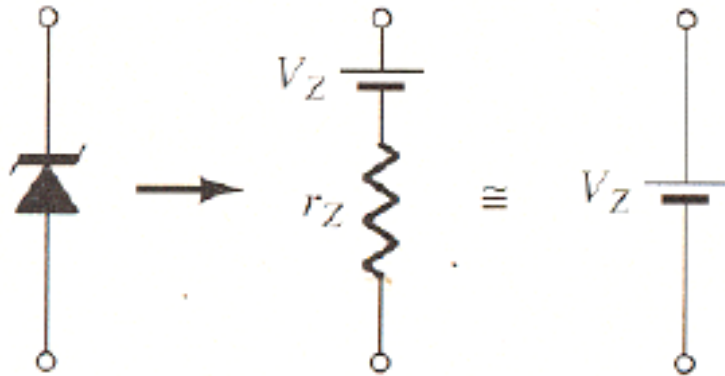
Hoạt động giống diode thường
($V_\gamma = 0.7V$, Si)



V_Z : Điện áp ghim
của zener

Diode zener

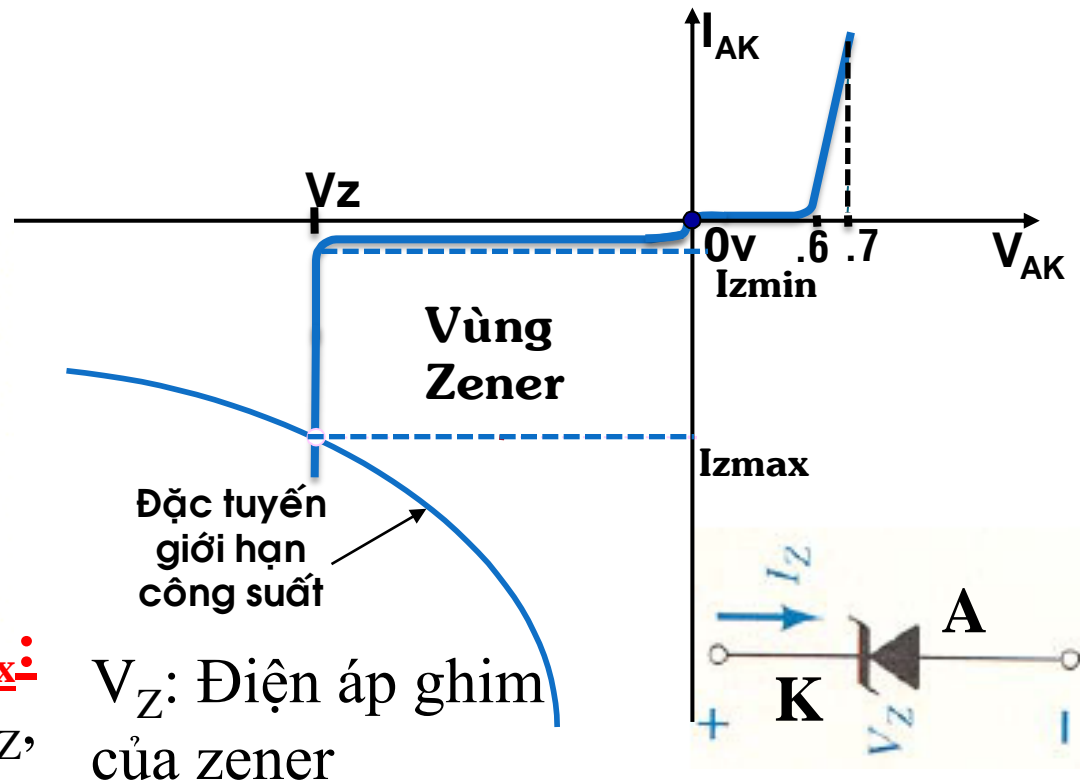
Phân cực ngược:



$$\underline{V_{KA} \geq V_Z \text{ và } I_{Zmin} \leq I_Z \leq I_{Zmax}:}$$

zener dẫn ngược $\rightarrow V_{KA} = V_Z$,
 $I_Z \neq 0$

$$\underline{V_{KA} < V_Z:} \text{ zener không dẫn, } I_Z = 0$$

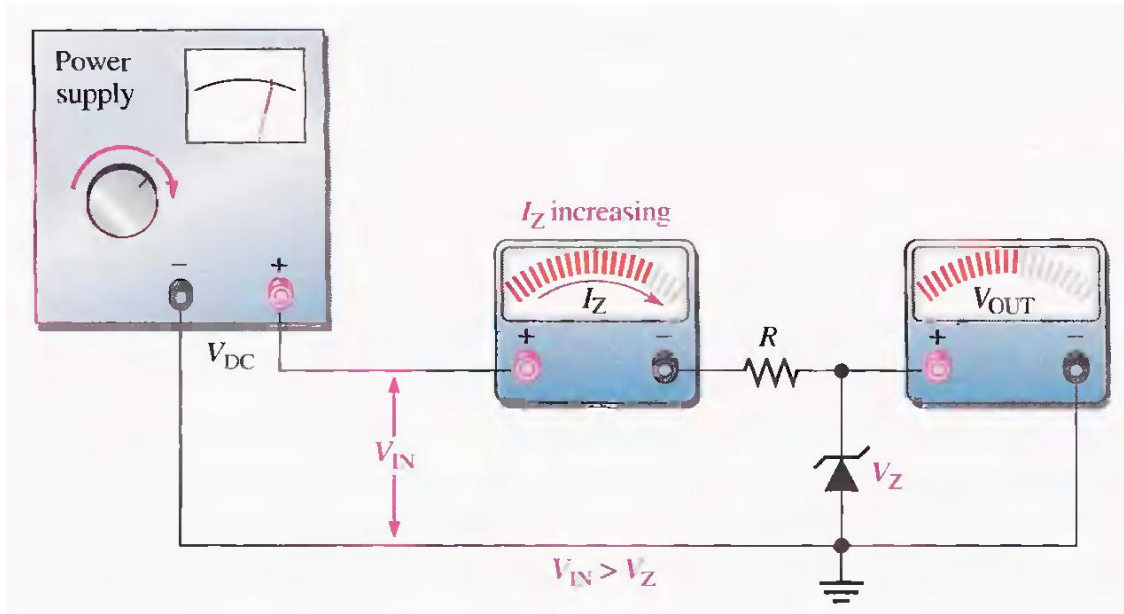


V_Z : Điện áp ghim của zener

- \rightarrow Ứng dụng phân cực ngược làm mạch ổn áp
- \rightarrow Thực tế $1.8V \leq V_Z \leq 200V$, công suất $0.25W : 50W$



Diode zener - Ứng dụng mạch ổn áp

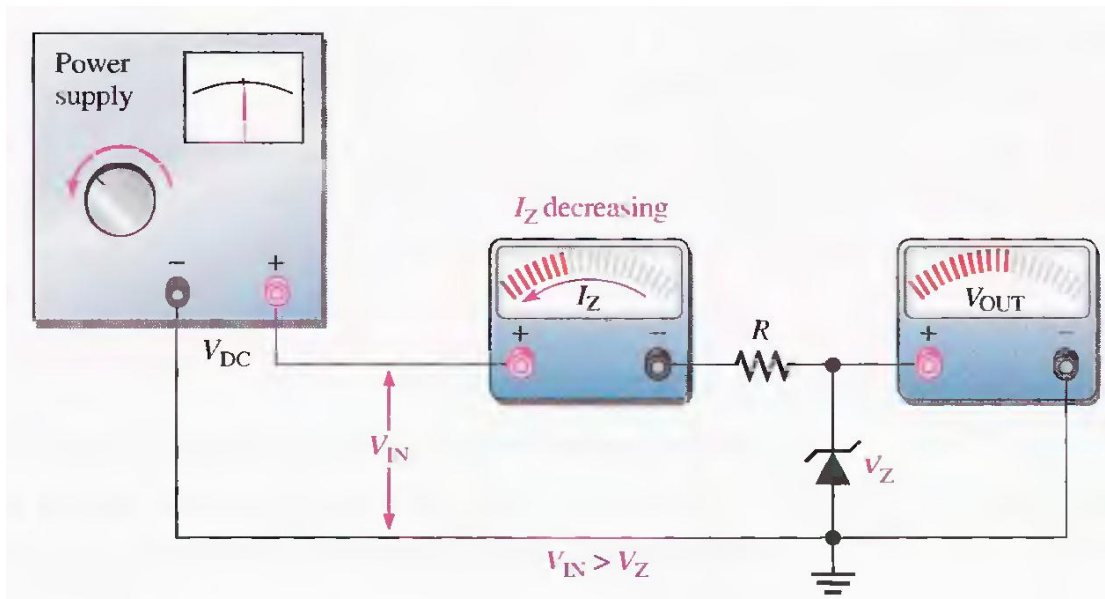


Điện áp vào tăng

$$V_{in} > V_z$$

Dòng qua zener tăng

$$I_{zmin} < I_z < I_{zmax}$$



Điện áp vào giảm

$$V_{in} > V_z$$

Dòng qua zener giảm

$$I_{zmin} < I_z < I_{zmax}$$



Diode zener - Ứng dụng mạch ổn áp

