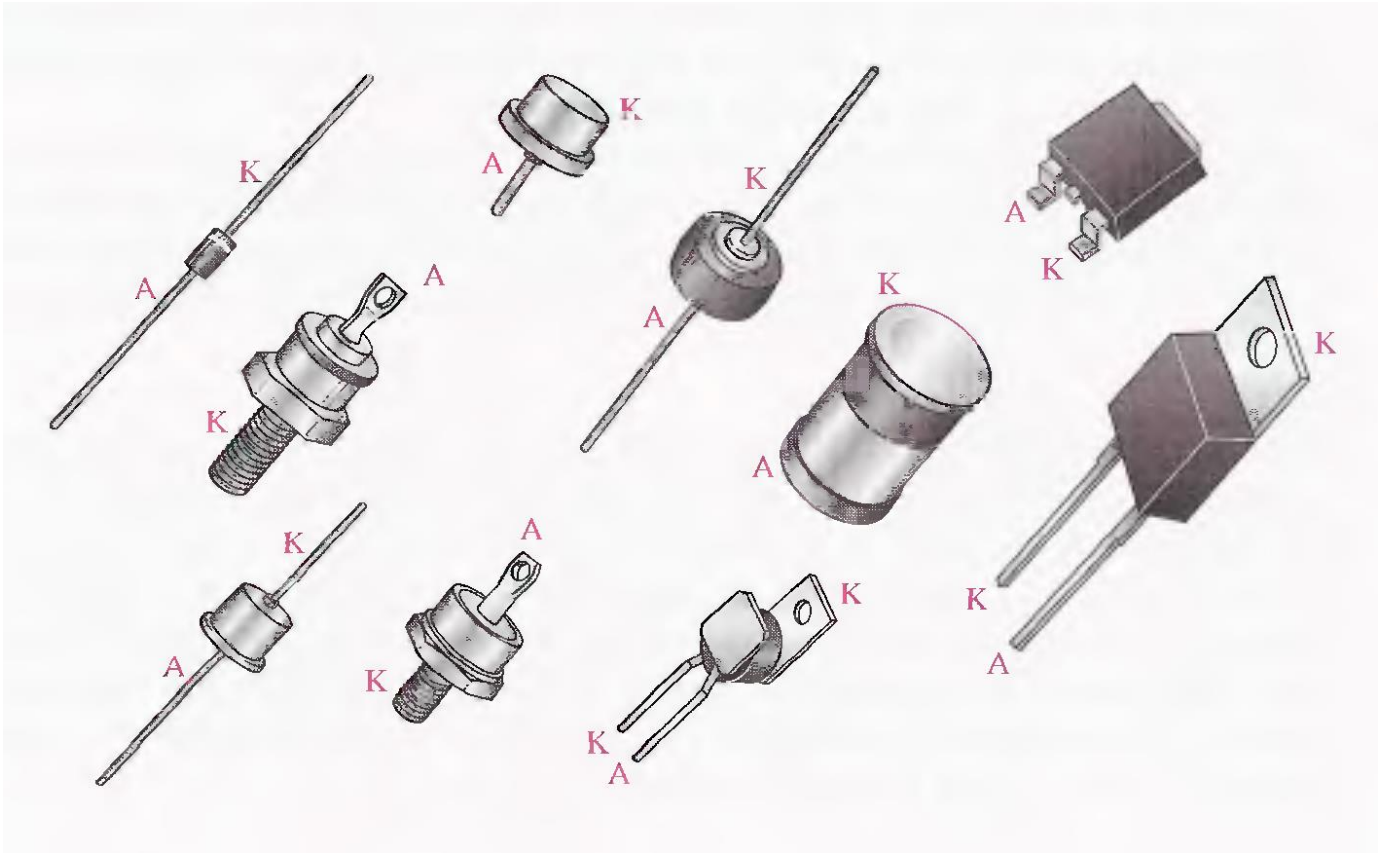
Chương 1:

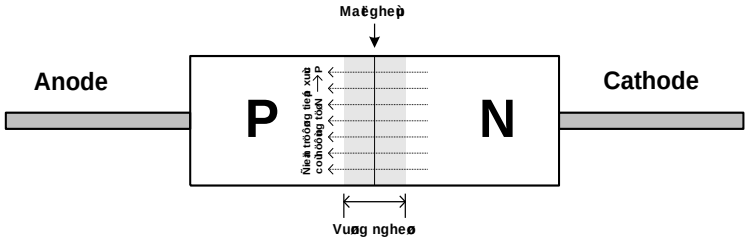
LINH KIỆN BÁN DẪN 2 LỚP VÀ ỨNG DỤNG (TT)

DIODE

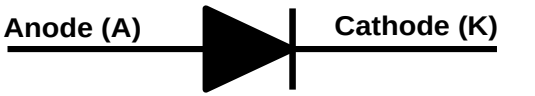


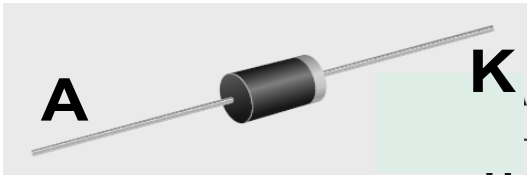
Diode chỉnh lưu

Cấu tạo

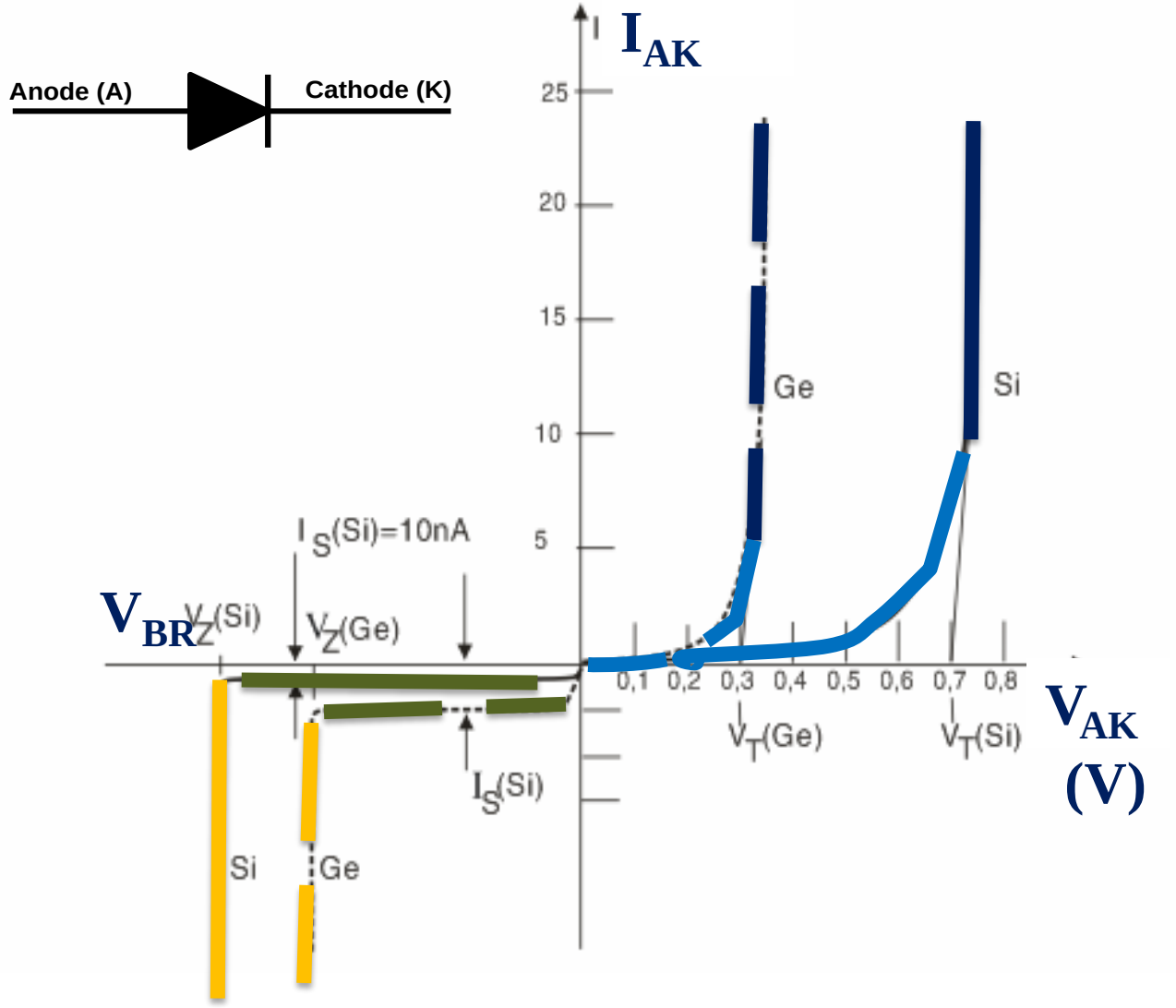


Symbol:





Đặc tuyến Volt Ampere

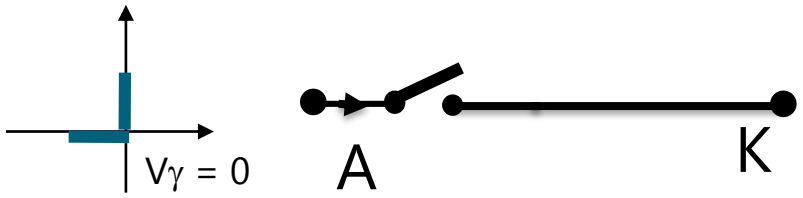


Vùng đánh thủng

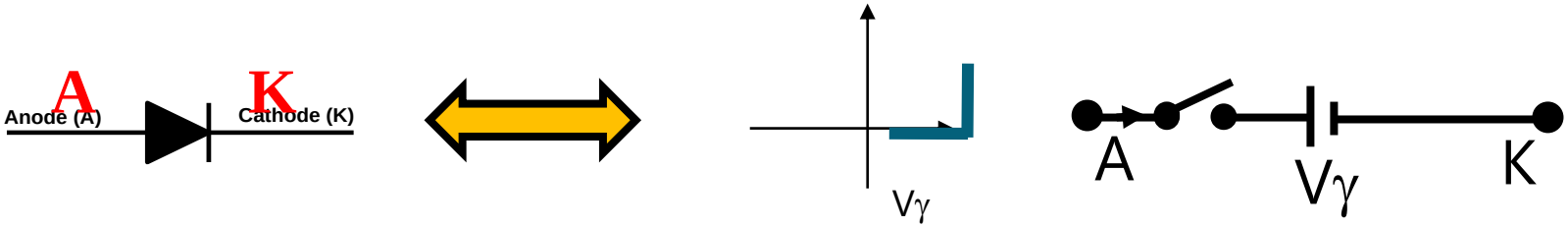
Vùng dẫn $V_{AK} > V\gamma$

Vùng phân cực ngược

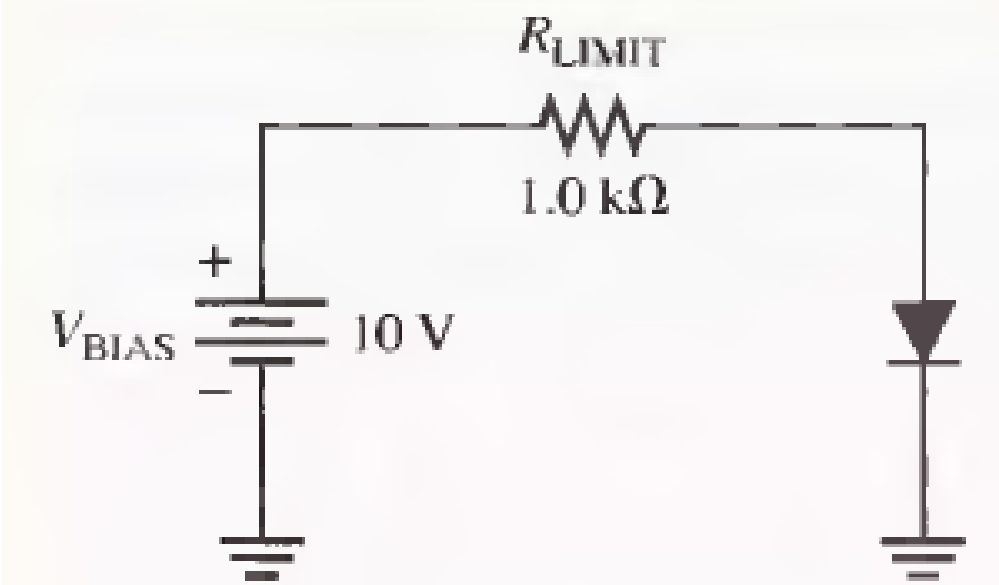
Models of Diode



Ideal Model Vγ= 0 (Diode lý tưởng)



Practical Model (Sụt áp là hằng số)



Ideal model:

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

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

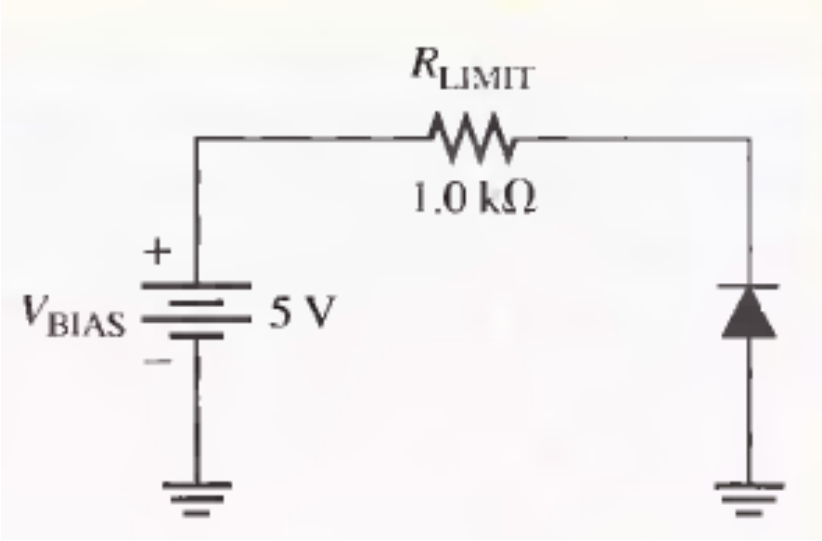
Practical model:

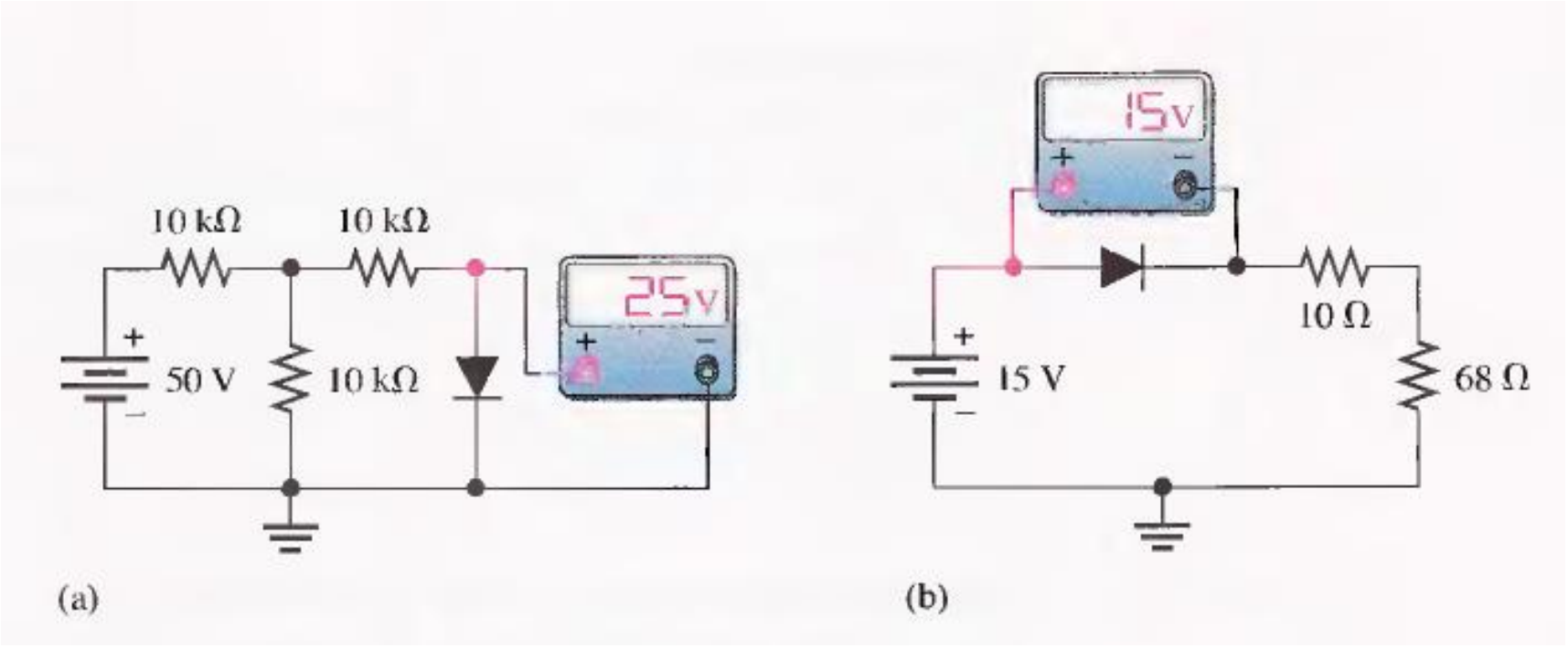
$$V_F = \mathbf{0.7\ V}$$

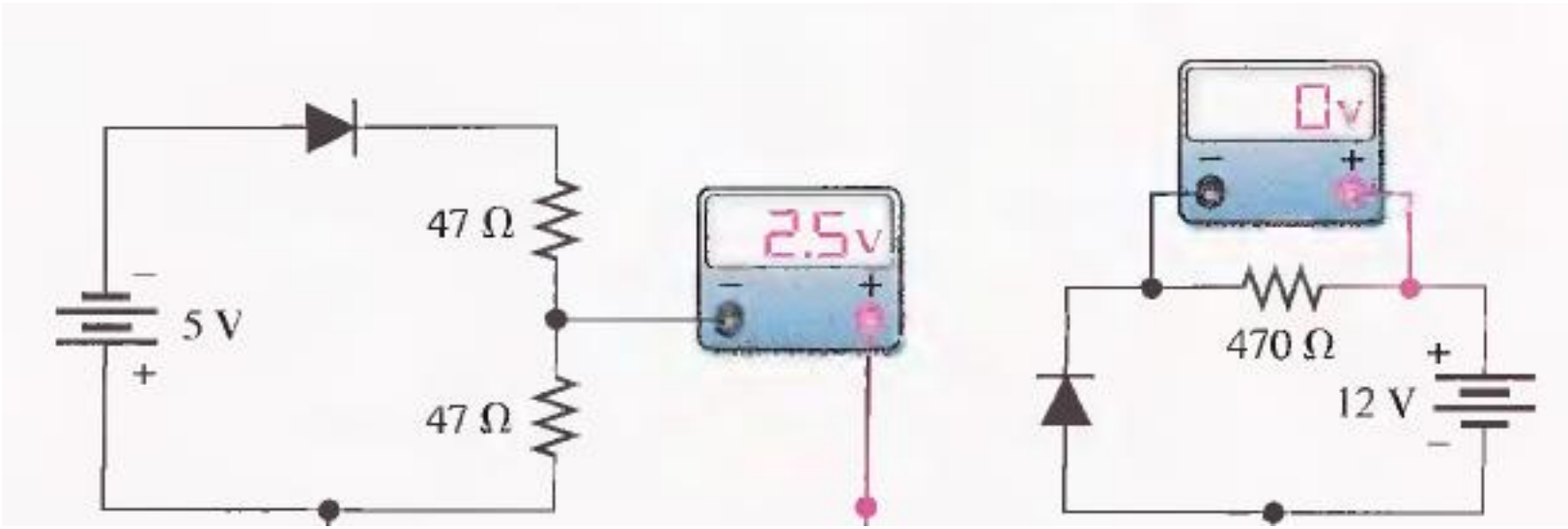
$$I_F = \frac{V_{BIAS} - V_F}{R_{LIMIT}} = \frac{10\ V - 0.7\ V}{1.0\ k\Omega} = \frac{9.3\ V}{1.0\ k\Omega} = \mathbf{9.3\ mA}$$

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

Reverse bias : $I_R = 0$




10 kΩ
10 kΩ
50 V
10 kΩ
25v
(a)
15v
10 Ω
15 V
68 Ω
(b)


47 Ω
5 V
47 Ω
2.5v
0v
470 Ω
12 V

Datasheet Diode

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

Datasheet của Diode

MAXIMUM RATINGS

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

ELECTRICAL CHARACTERISTICS*

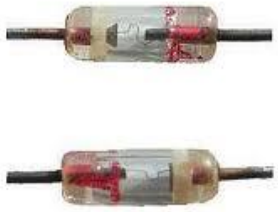
Rating	Symbol	Typ	Max	Unit
Maximum Instantaneous Forward Voltage Drop (i_F = 1.0 Amp, T_J = 25°C) Figure 1	v_F	0.93	1.1	Volts
Maximum Full–Cycle Average Forward Voltage Drop (I_O = 1.0 Amp, T_L = 75°C, 1 inch leads)	$V_{F(AV)}$	—	0.8	Volts
Maximum Reverse Current (rated dc voltage) (T_J = 25°C) (T_J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

*Indicates JEDEC Registered Data

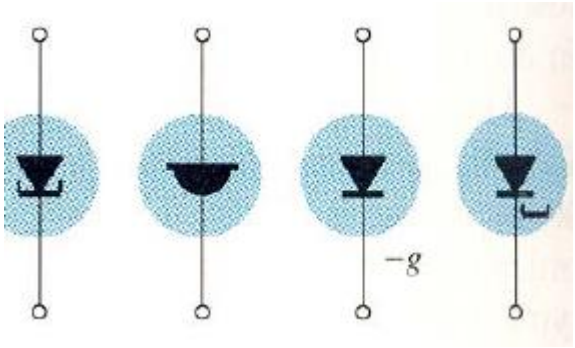
Preferred devices are Motorola recommended choices for future use and best overall value.

CÁC LOẠI DIODE

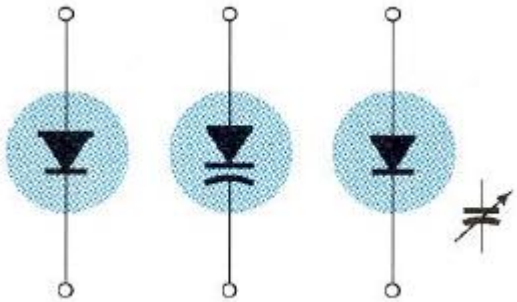
Diode taùch soùng : söû duïng tieáp xuùc ñieåm ñeå ñieän dung beù → laøm vieäc ôû taàn soá cao

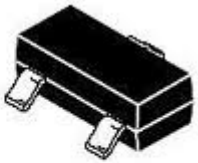


Diode tunnel : **noàng ñoä taïp chaát raát cao** → öùng duïng trong caùc maïch sieâu cao taàn



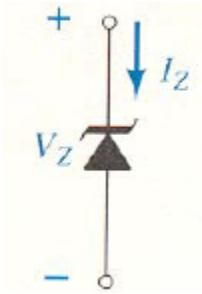
Diode bieán dung : coù lôùp tieáp xuùc ñaëc bieät ñeå dieän dung khaù tuyeán tính vôùi ñieän aùp ngöôïc → taïo soùng ñieàu taàn deå ñieàu chænh taàn soá coäâng höôûng





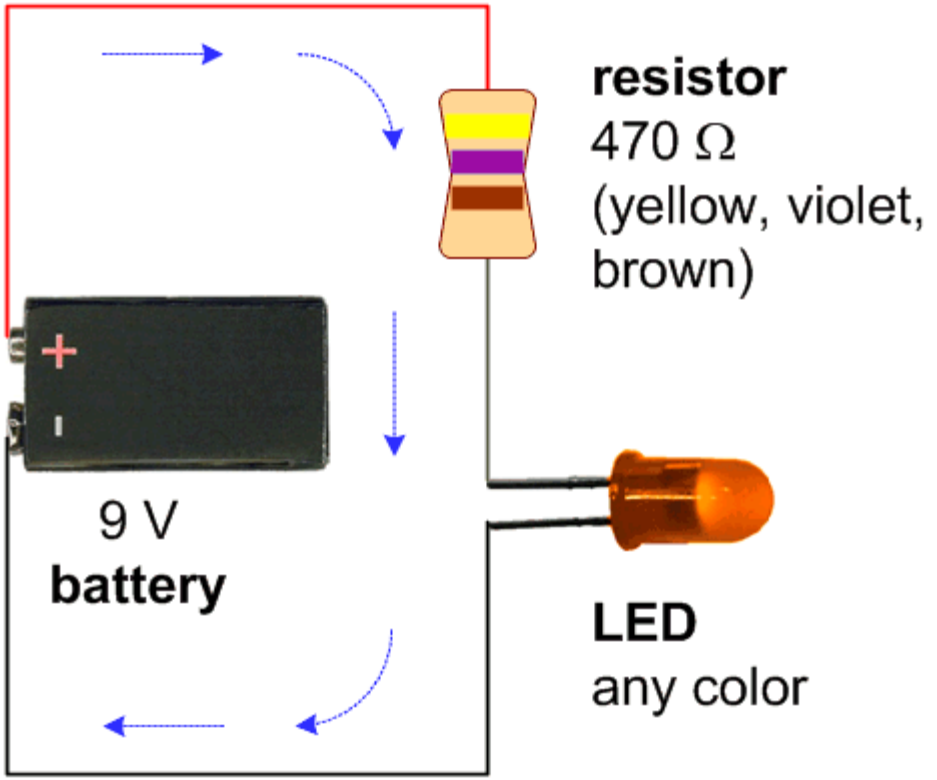
Diode Schottky : tiếp xúc Schottky (bán dẫn, kim loại) → ứng dụng cho những mạch cần tốc độ chuyển mạch cao

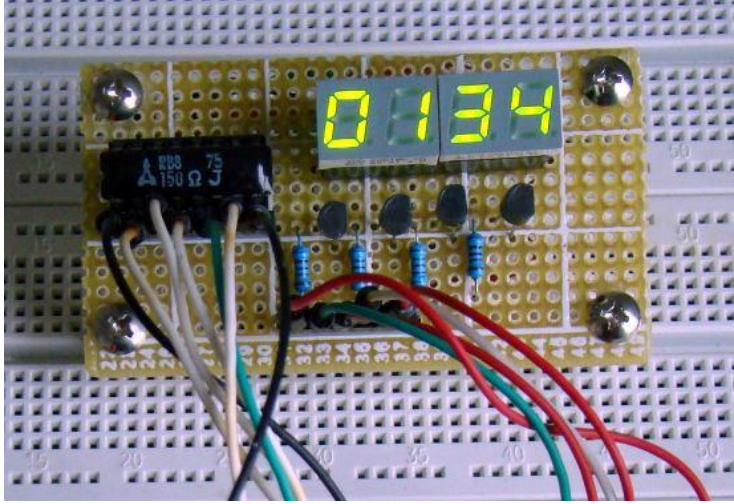
Diode Zener : thường bằng vật liệu Si chịu nhiệt và tỏa nhiệt tốt hoạt động chủ yếu vùng zener töø (1,8 ÷ 200)V

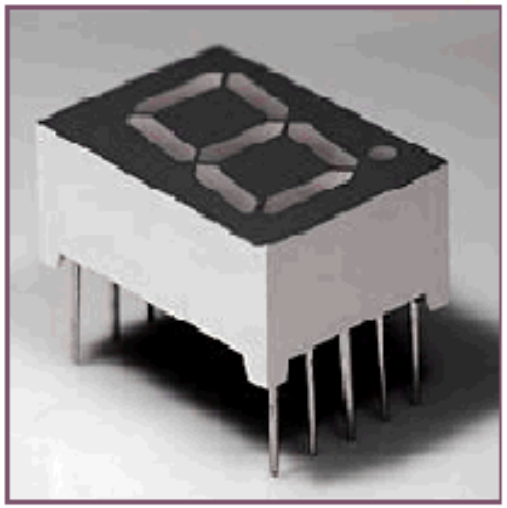


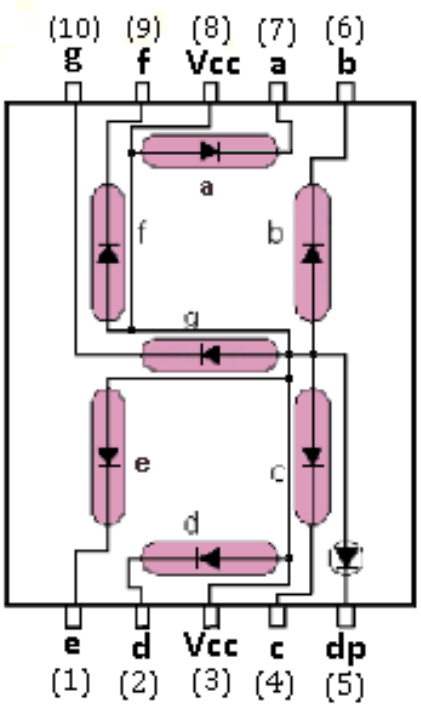
Diode phát quang : thường dùng bán dẫn hợp chất có mức Wg thay đổi điều chỉnh được theo nồng độ tạp chất, sử dụng yếu tố phát sáng bước sóng λ nhìn thấy được khi phân cực thuận có sự tái hợp e^- và lỗ trống

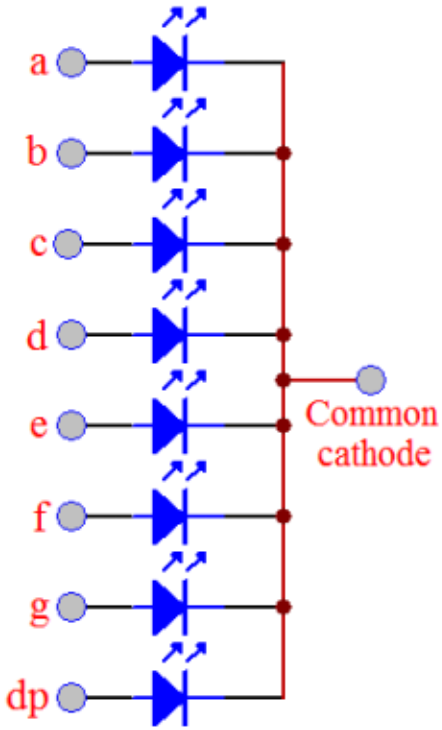
Color of LED	Voltage Drop (Volt)
Red	1.63 ~ 2.03
Yellow	2.10 ~ 2.18
Orange	2.03 ~ 2.10
Blue	2.48 ~ 3.7
Green	1.9 ~ 4.0
Violet	2.76 ~ 4.0
UV	3.1 ~ 4.4
White	3.2 to 3.6

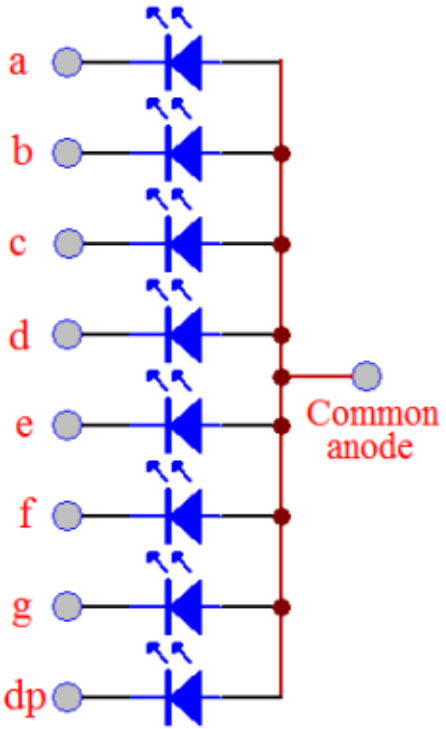










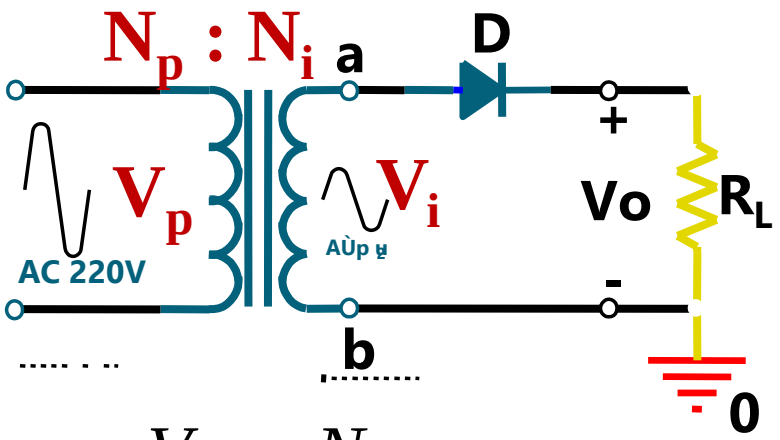


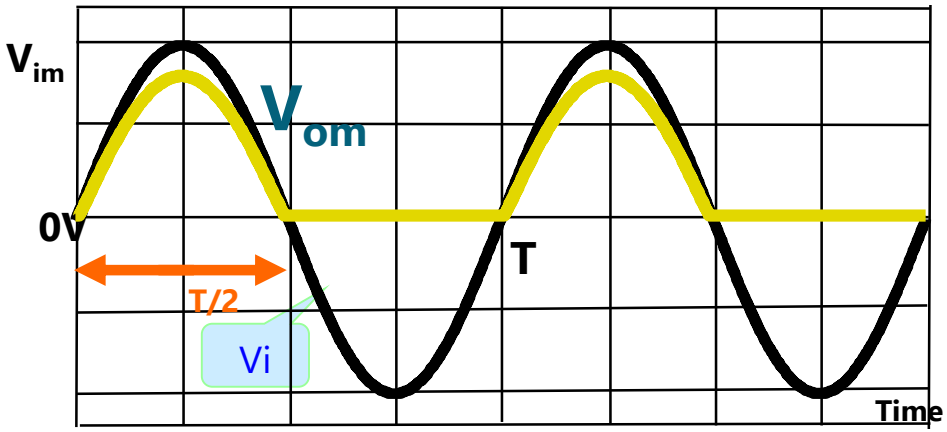
Common Anode Mode

APPLICATONS

Chỉnh lưu - Rectifier(AC →DC)

a. Chỉnh lưu bán kỳ - Half Wave Rectifier

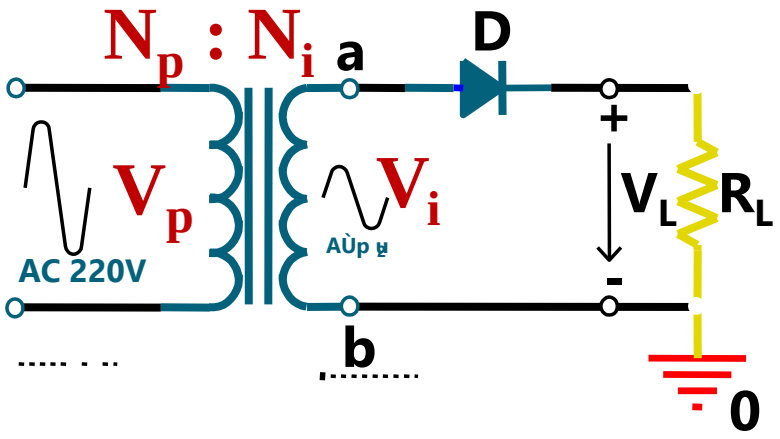




$$\frac{V_P}{V_i} = \frac{N_P}{N_i}$$

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

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

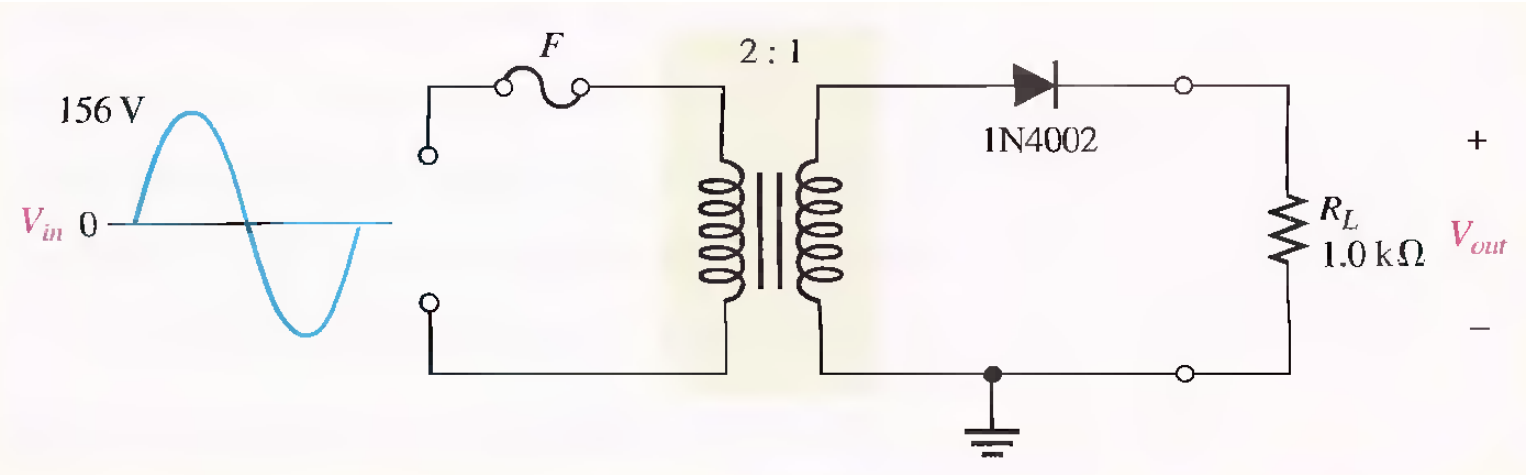
Dòng trung bình qua diode

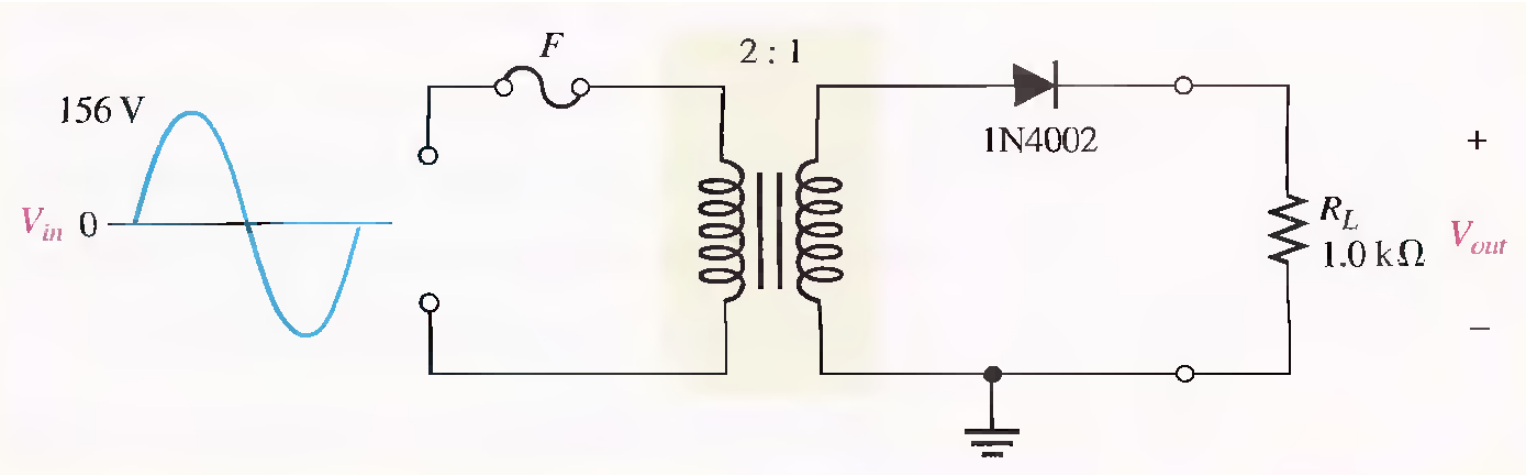
$$I_{DC_{DIODE}} = I_{ODC}$$

(PIV – Peak Inverse Voltage)

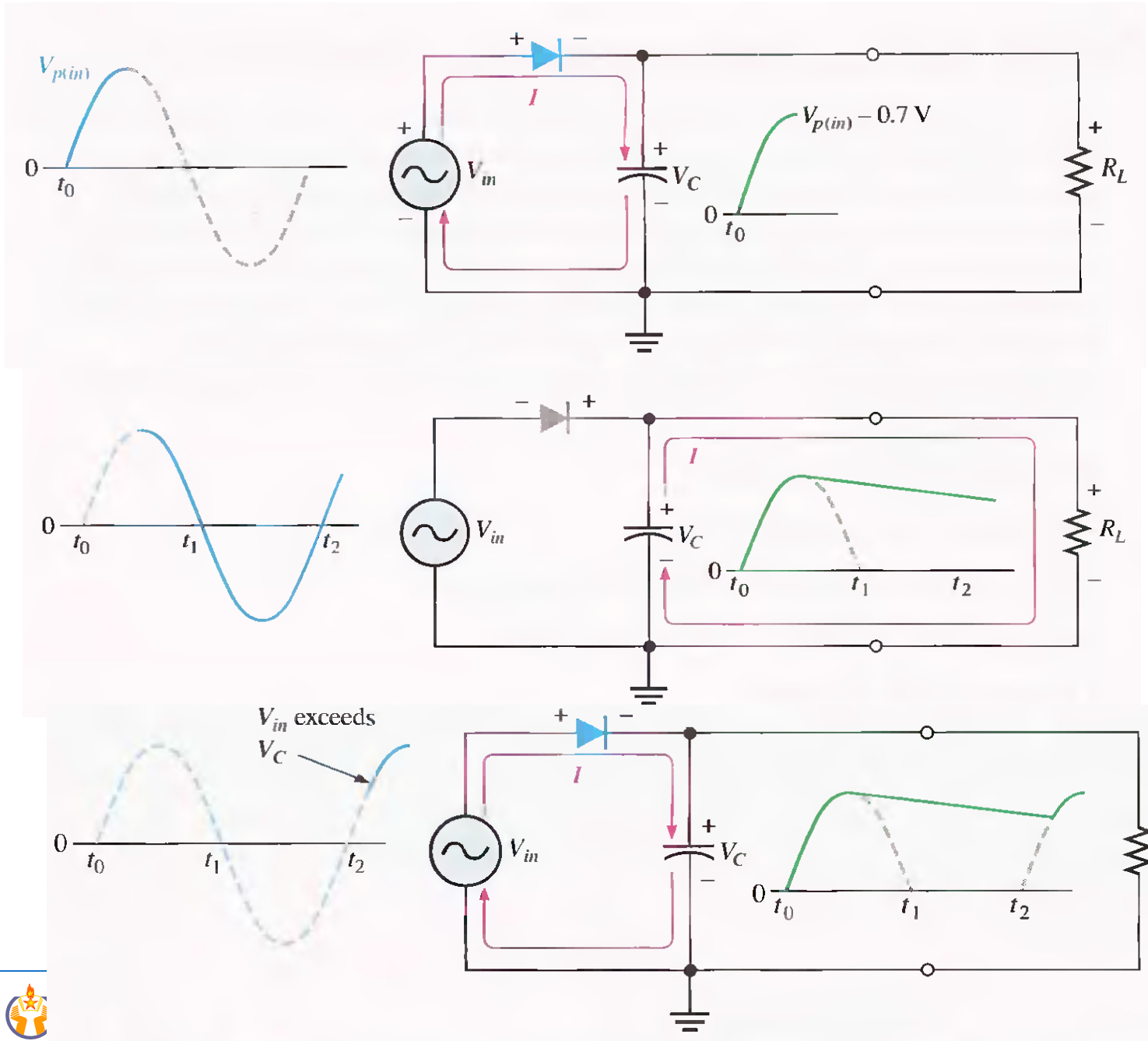
$$PIV = V_{im}$$

Vd:

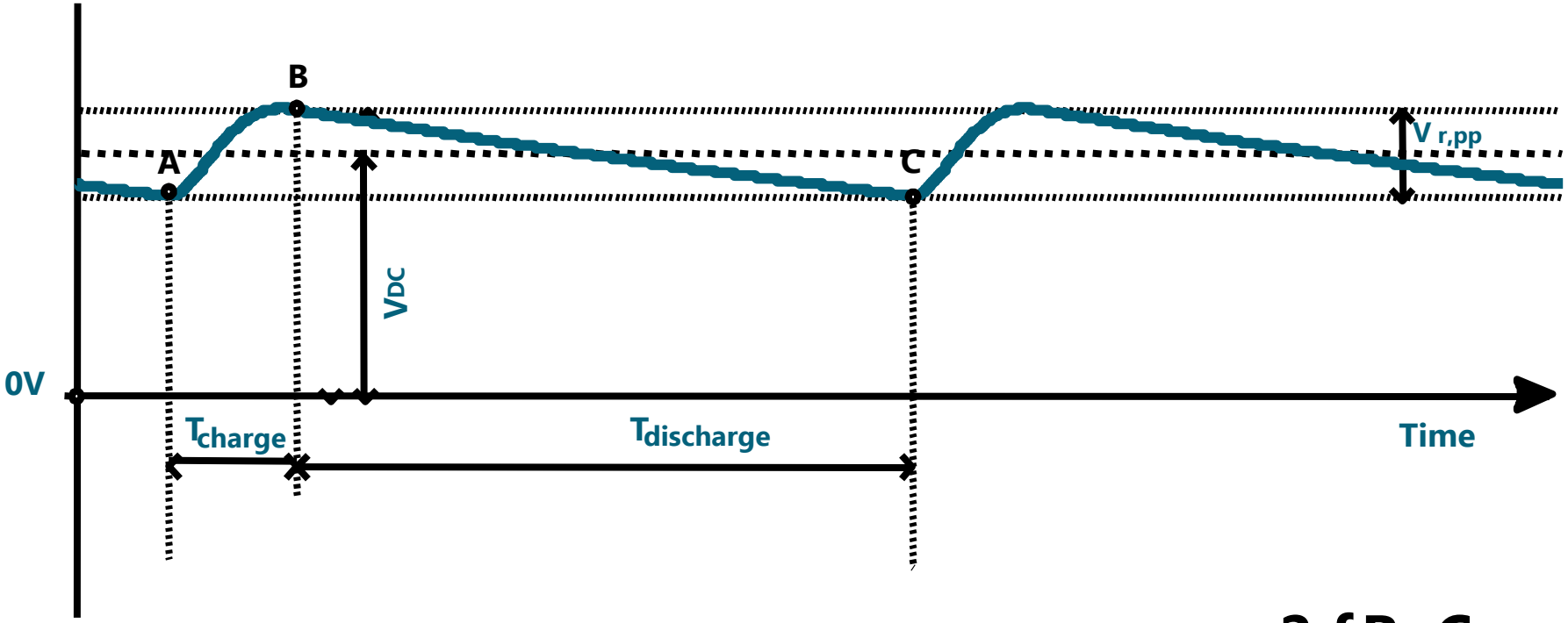



156 V
V_{in} 0
F
2 : 1
1N4002
R_L
1.0 kΩ
+
V_{out}
–

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



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



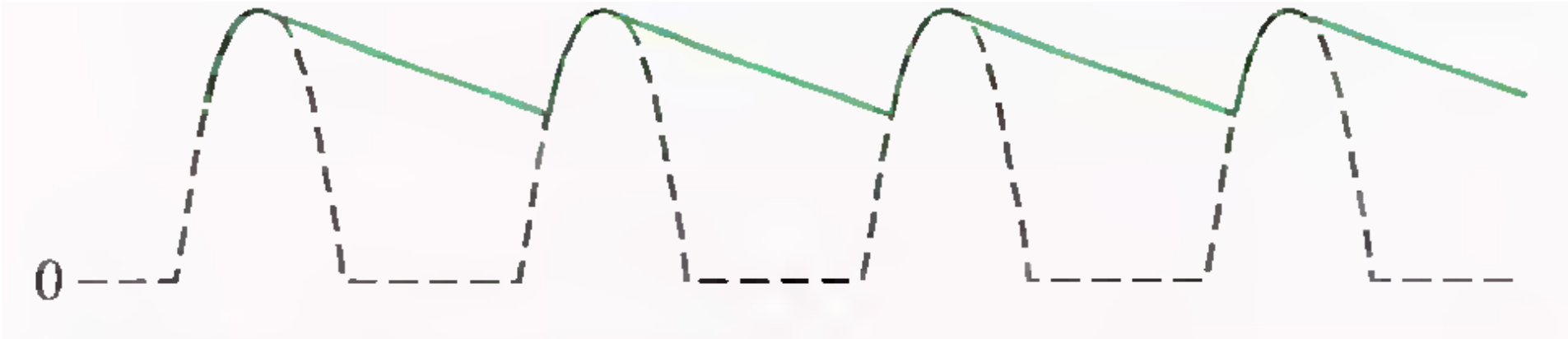
Điện áp trung bình trên tải

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

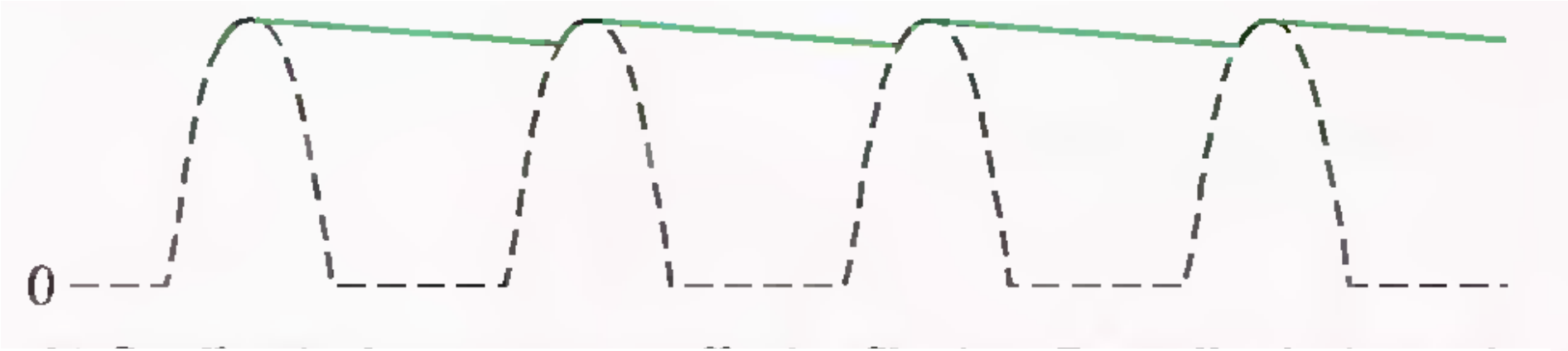
Độ gợn sóng của điện áp trên tải

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

Chỉnh lưu bán kỳ có tụ lọc

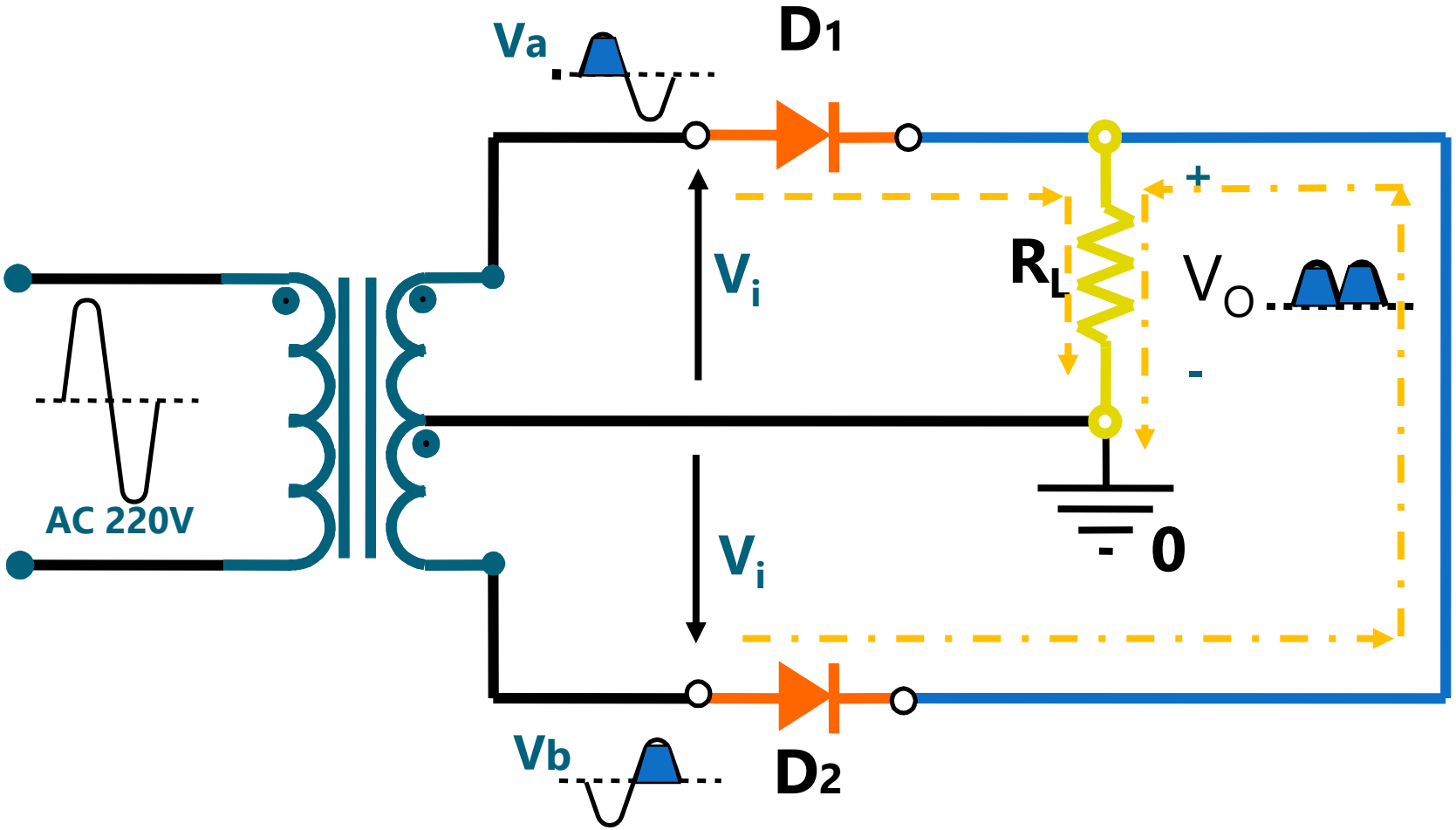


Tụ lọc có giá trị nhỏ → độ gợn sóng lớn

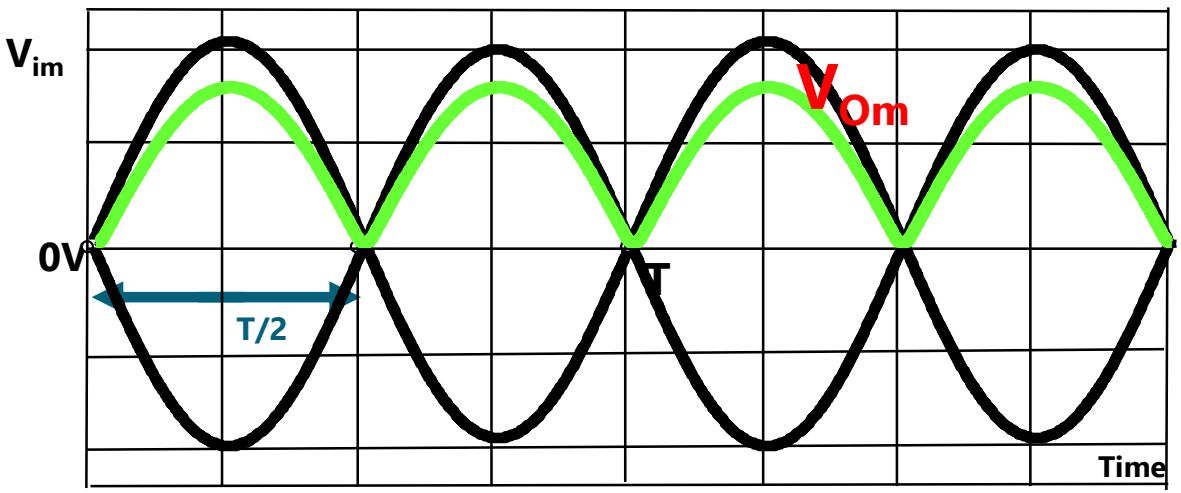


Tụ lọc có giá trị lớn → độ gợn sóng nhỏ

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



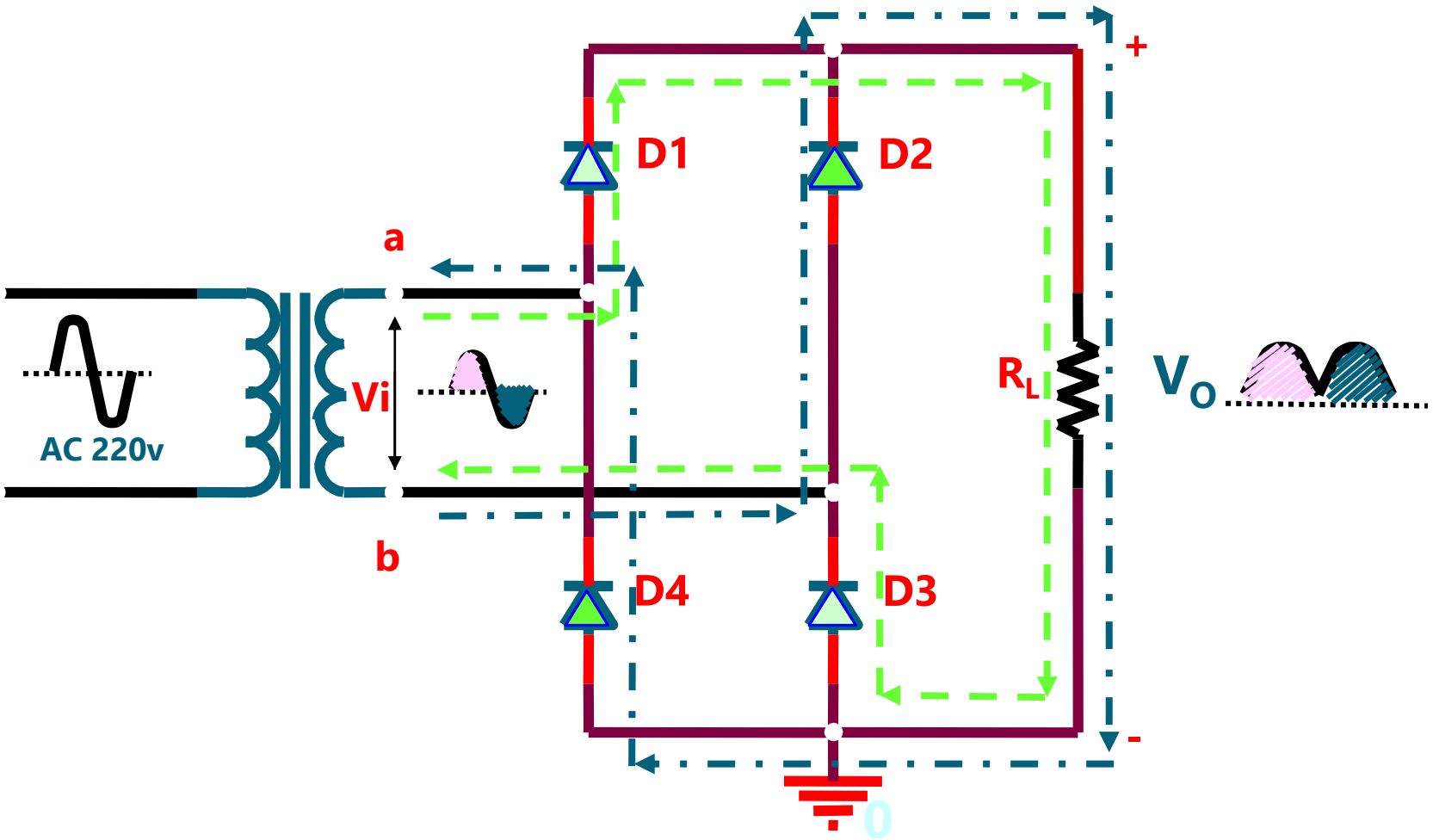
Chỉnh lưu toàn kỳ dùng biến áp đôi - Full Wave Rectifier using center – tapped tranformer



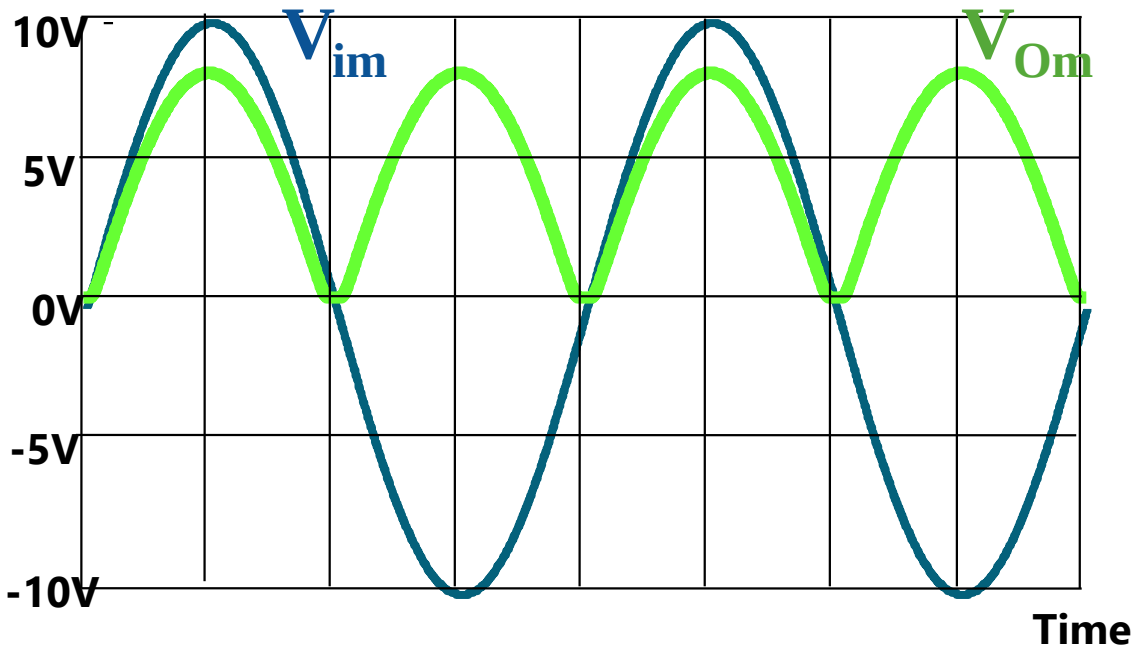
$$V_{ODC} = \frac{1}{T}\int_0^T V_O(t)dt = \frac{1}{2\pi}\int_0^{2\pi} V_{Om}\sin(\omega t)d(\omega t) = 2\frac{V_{Om}}{\pi} = 2\frac{V_i - V_\gamma}{\pi}$$

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

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



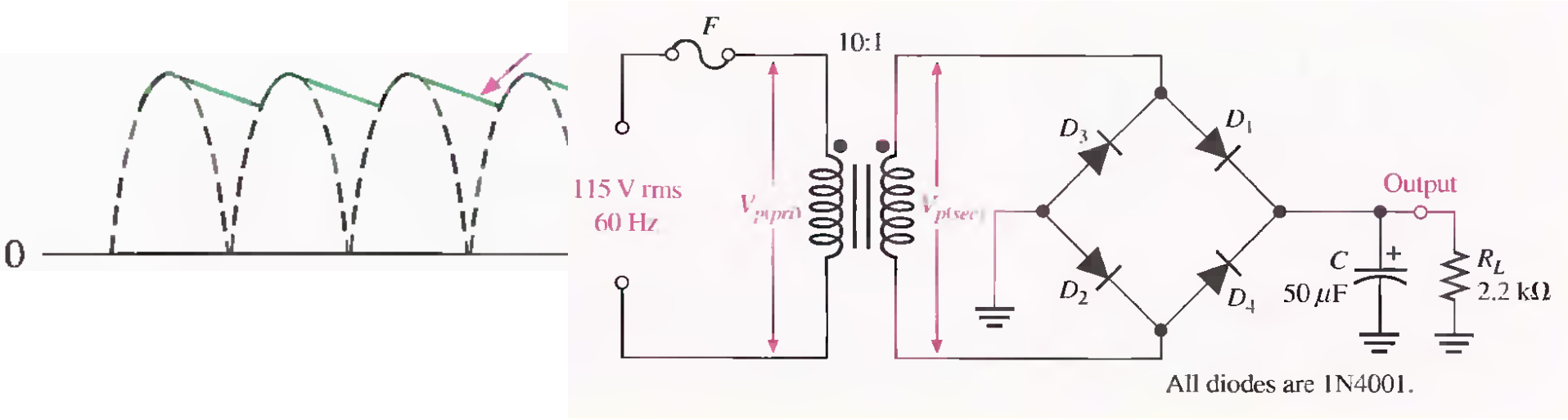
$$V_{ODC} = 2\frac{V_{Om}}{\pi} = 2\frac{V_{im} - 2V_{\gamma}}{\pi}$$

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

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

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

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



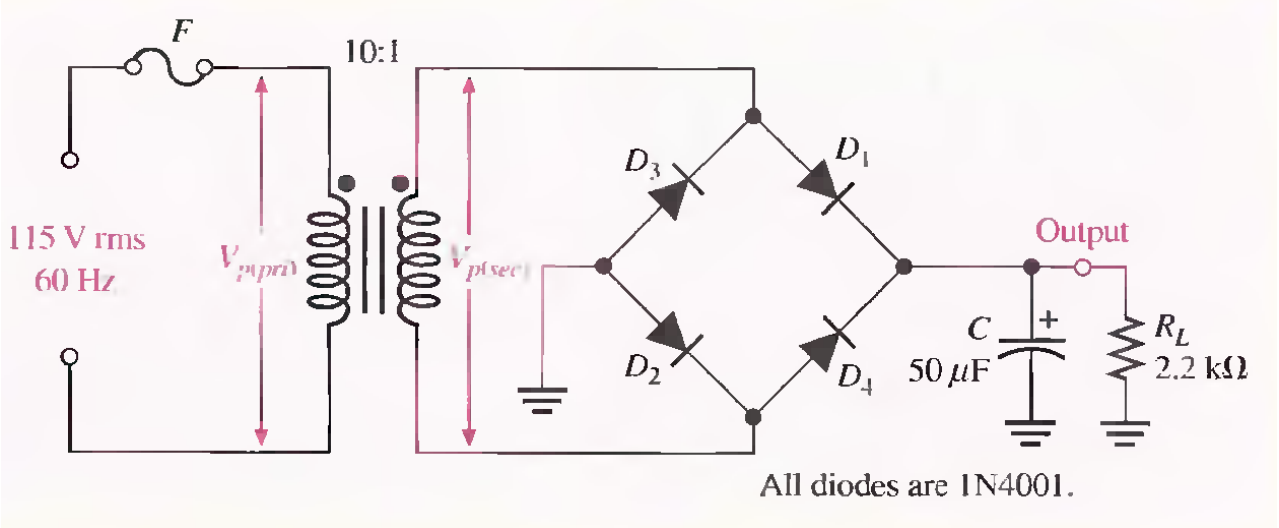
Điện áp trung bình trên tải

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

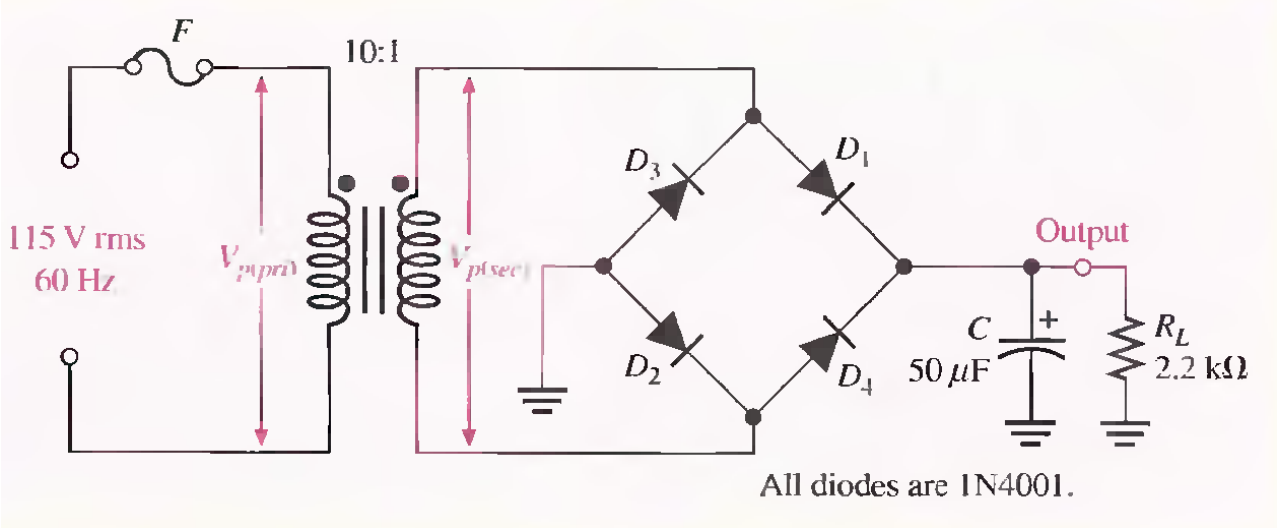
Độ gợn sóng của điện áp ngõ ra

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

Vd

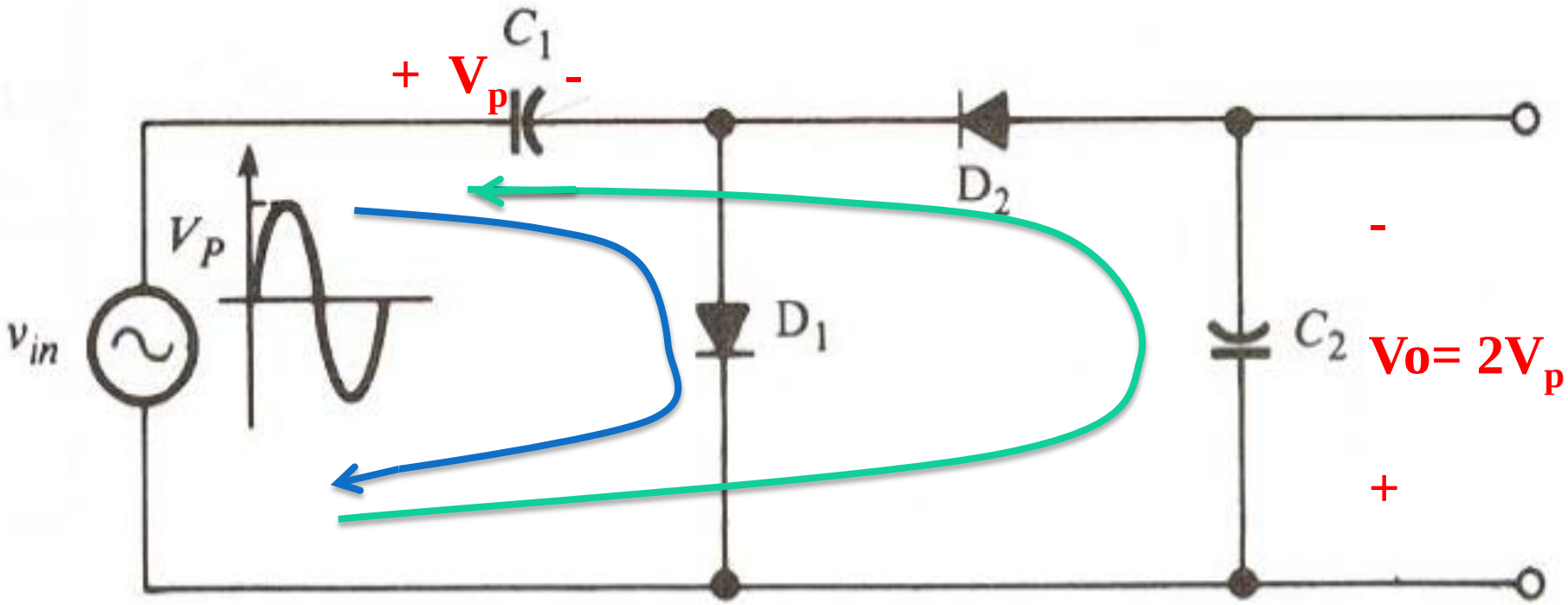

F
10:1
115 V rms
60 Hz
$V_{p(pri)}$
$V_{p(sec)}$
D_3
D_1
D_2
D_4
Output
C
50 μF
R_L
2.2 kΩ
All diodes are 1N4001.

Vd

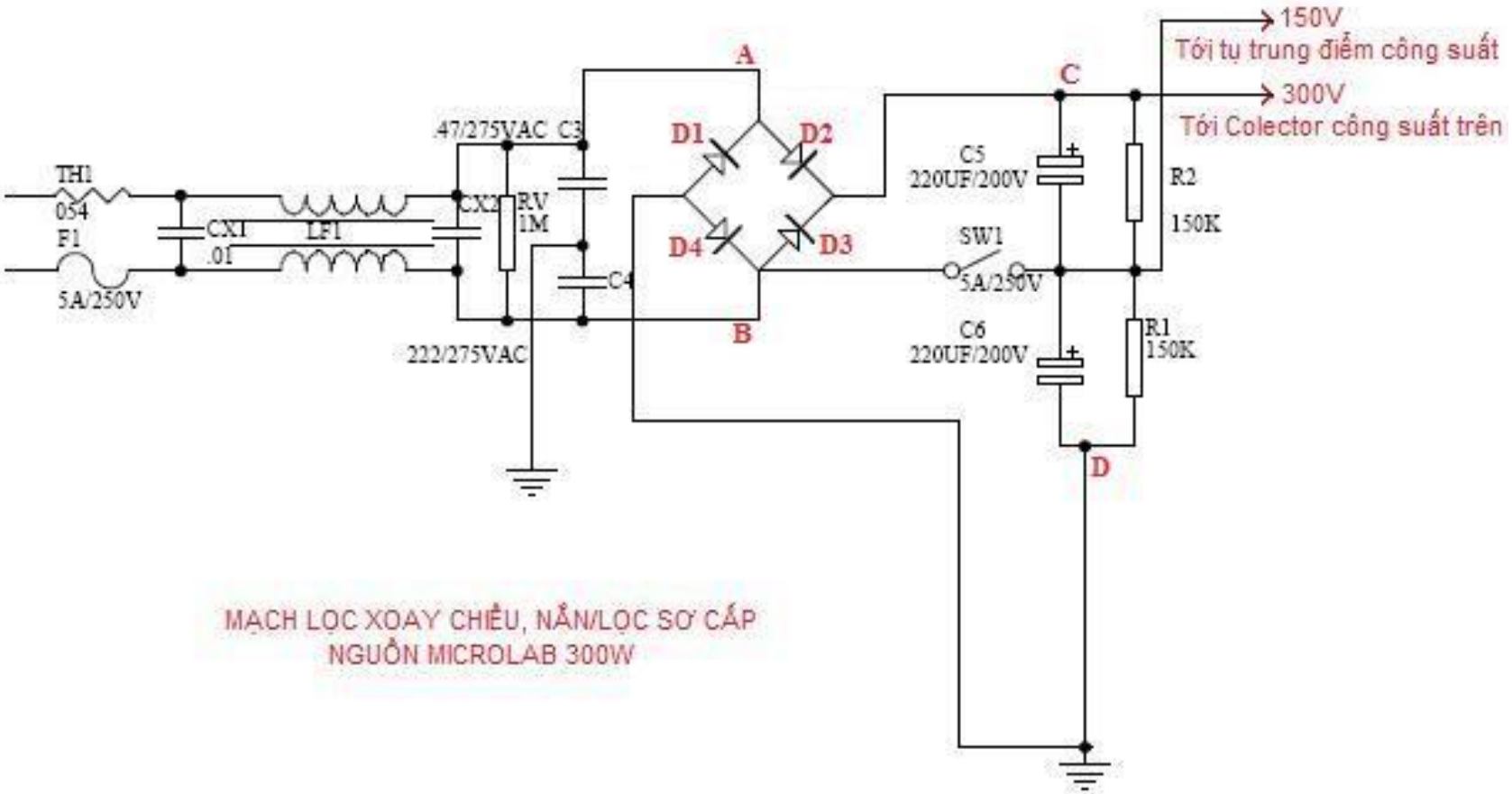

F
10:1
115 V rms
60 Hz
$V_{p(pri)}$
$V_{p(sec)}$
D_3
D_1
D_2
D_4
Output
C
50 μF
R_L
2.2 kΩ
All diodes are 1N4001.

Mạch nhân áp

Mạch nhân áp bán kì



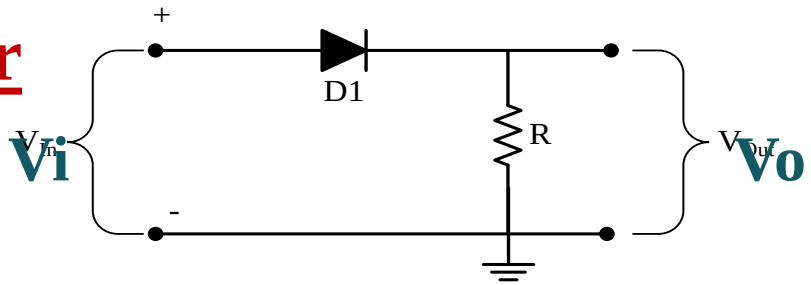
Ứng dụng

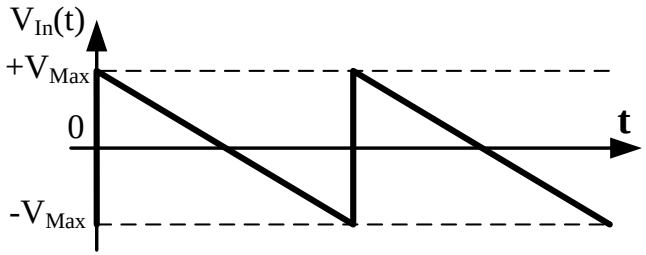


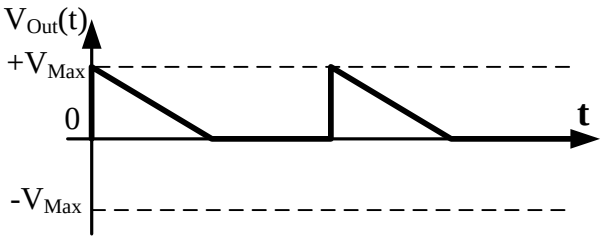
MẠCH LỌC XOAY CHIỀU, NẮN/LỌC SƠ CẤP
NGUỒN MICROLAB 300W

Mạch xén - Clipper

Mạch xén nối tiếp

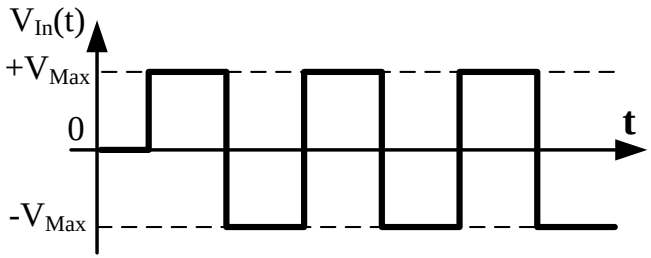


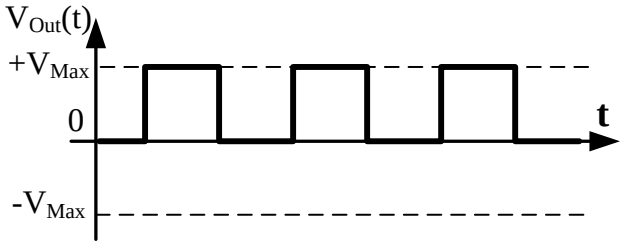


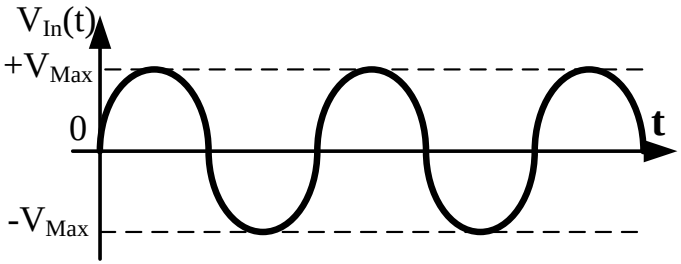


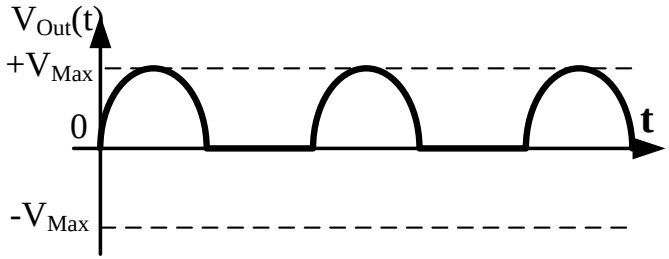
Vi

Vo



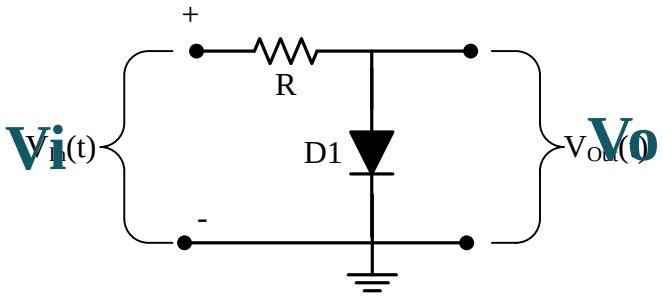


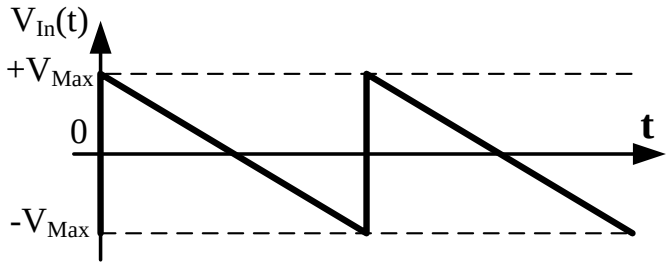


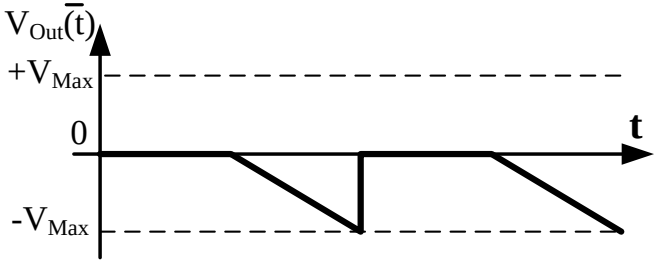


Mạch xén

Mạch xén song song

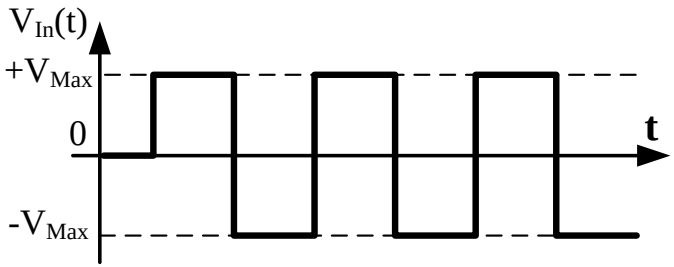


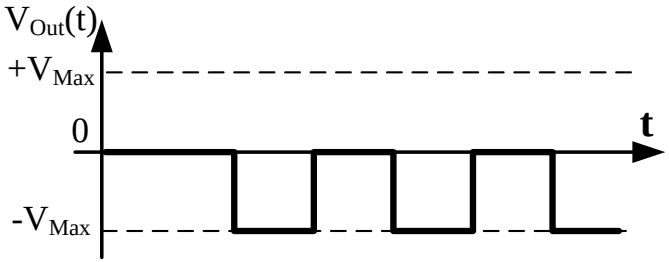


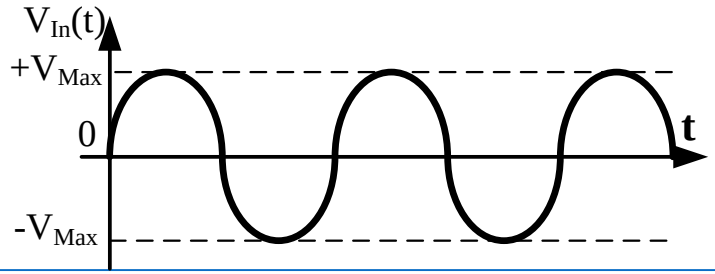


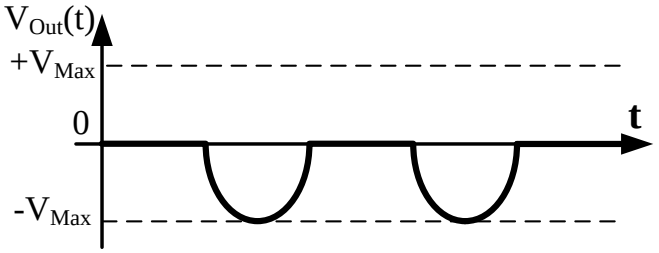
Vi

Vo









Mạch xén (Clippers)

Các bước làm bài

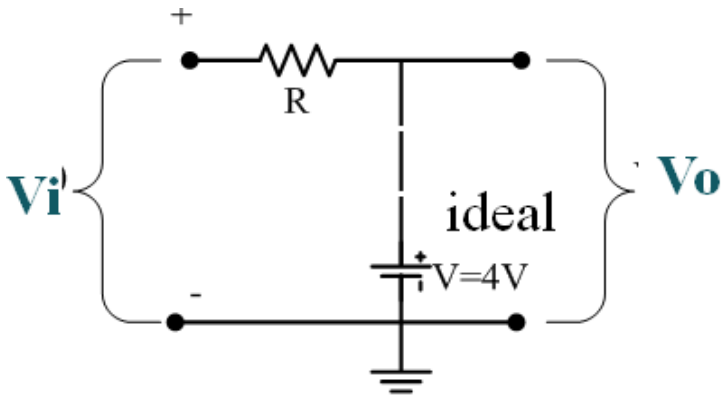
- Tìm điều kiện của Vi để Diode dẫn (dùng định luật Kirchhoff)
- Tìm Vo tương ứng khi Diode dẫn.
- Tìm điều kiện Vi để Diode ngưng dẫn (ngược lại điều kiện dẫn)
- Tìm Vo tương ứng khi Diode không dẫn.
- Vẽ Vo

Mạch xén

Mạch xén song song

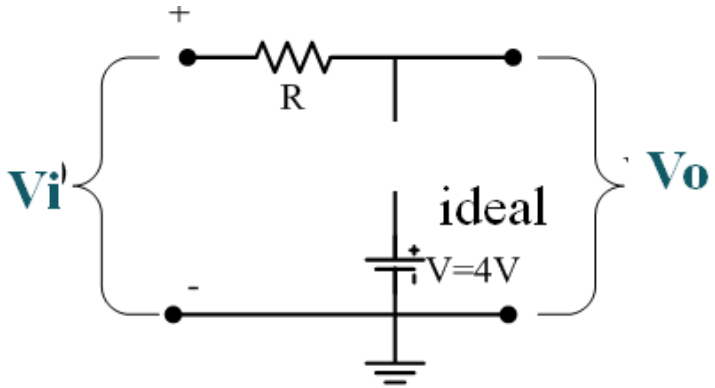
Điều kiện Vi để Diode dẫn Vi ≤ 4V

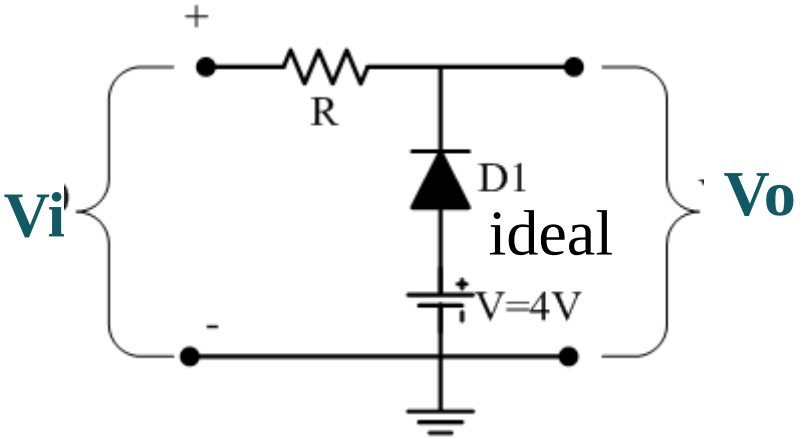
Khi đó Vo= 4V

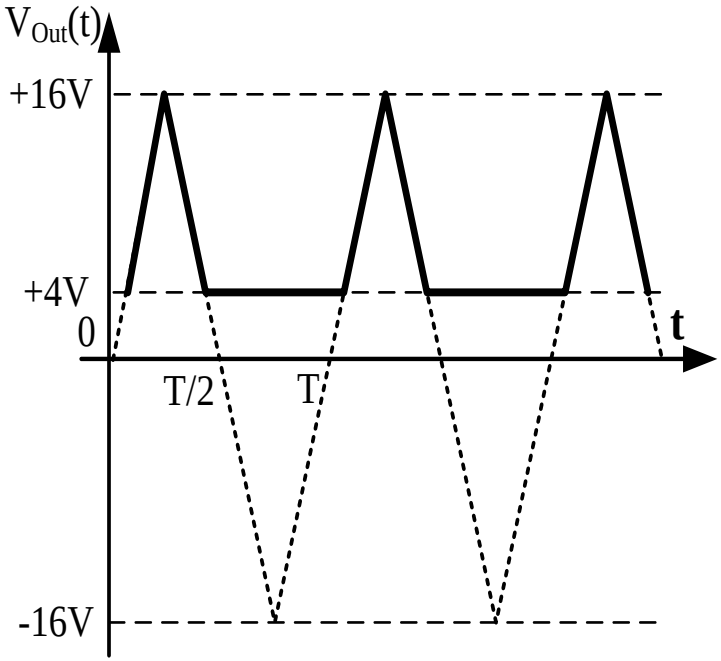


Diode không dẫn Vi ≥ 4V

Khi đó Vo = Vi



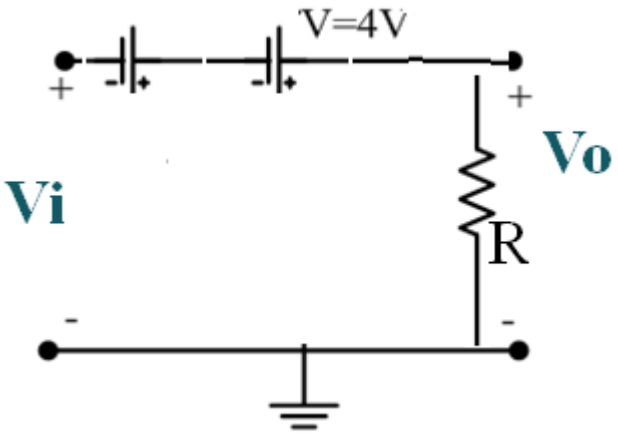


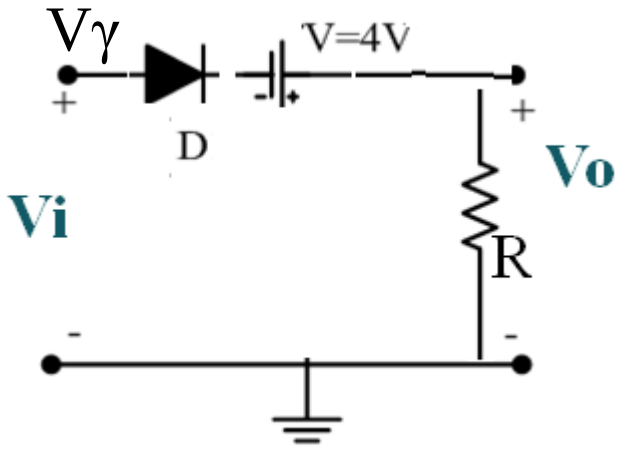


Mạch xén nối tiếp

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

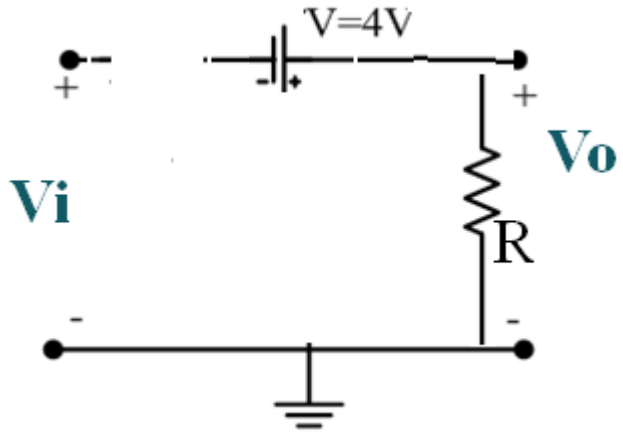
Khi đó $Vo = I.R_L = Vi + 4 - V_\gamma$

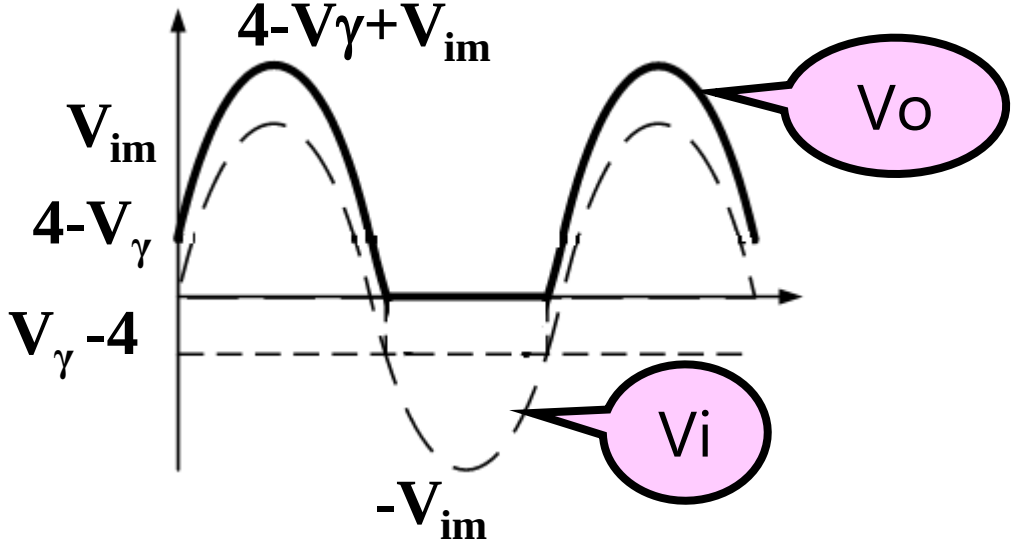




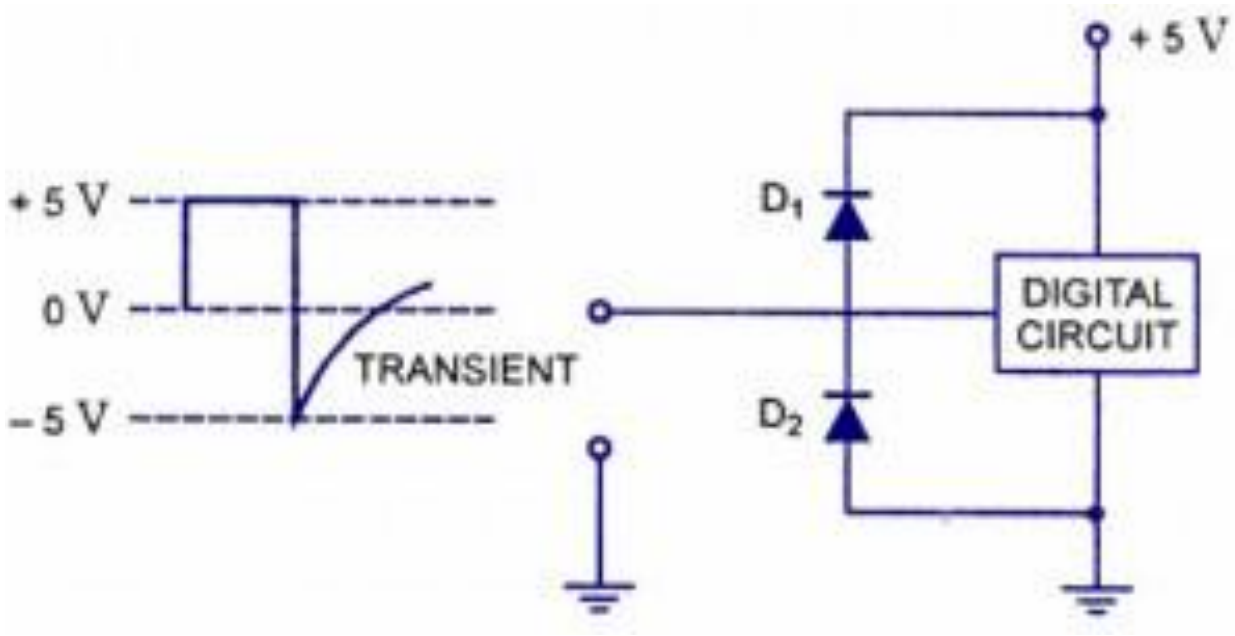
Diode ko dẫn khi : $V_i \leq (4 + V_\gamma)$

Khi đó $V_o = IR = 0$

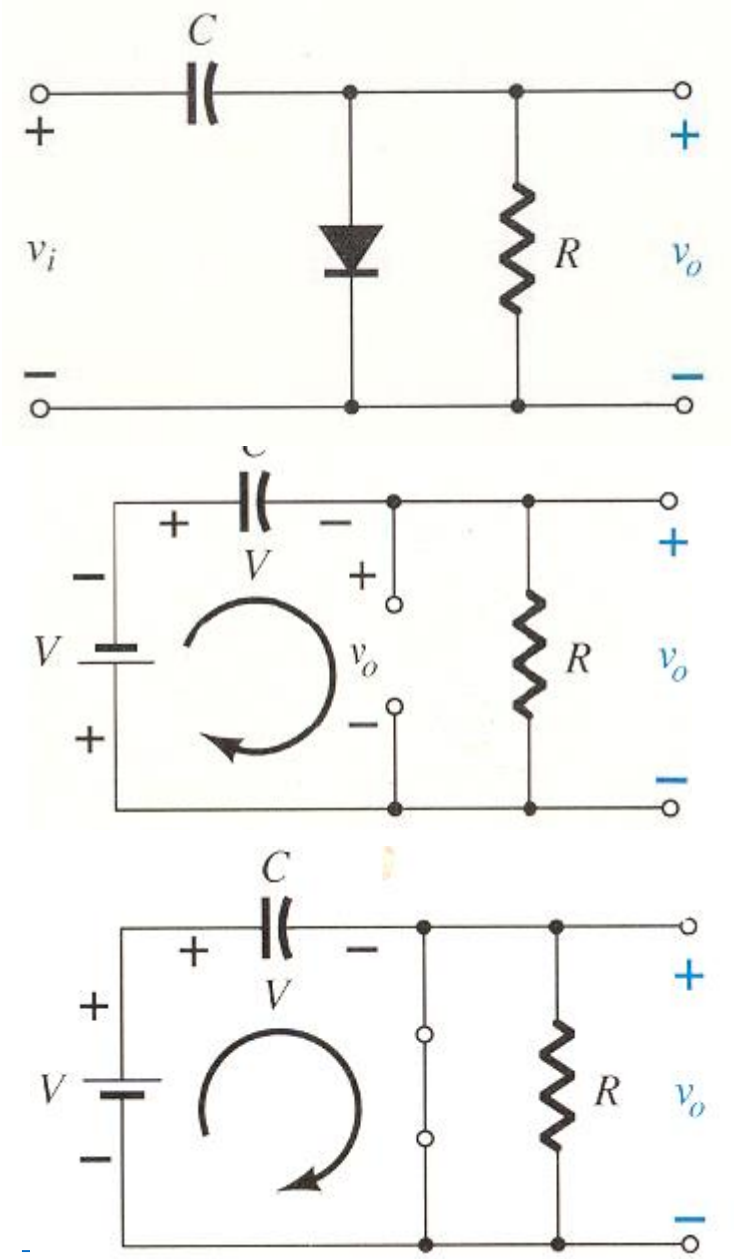




Ứng dụng mạch xén



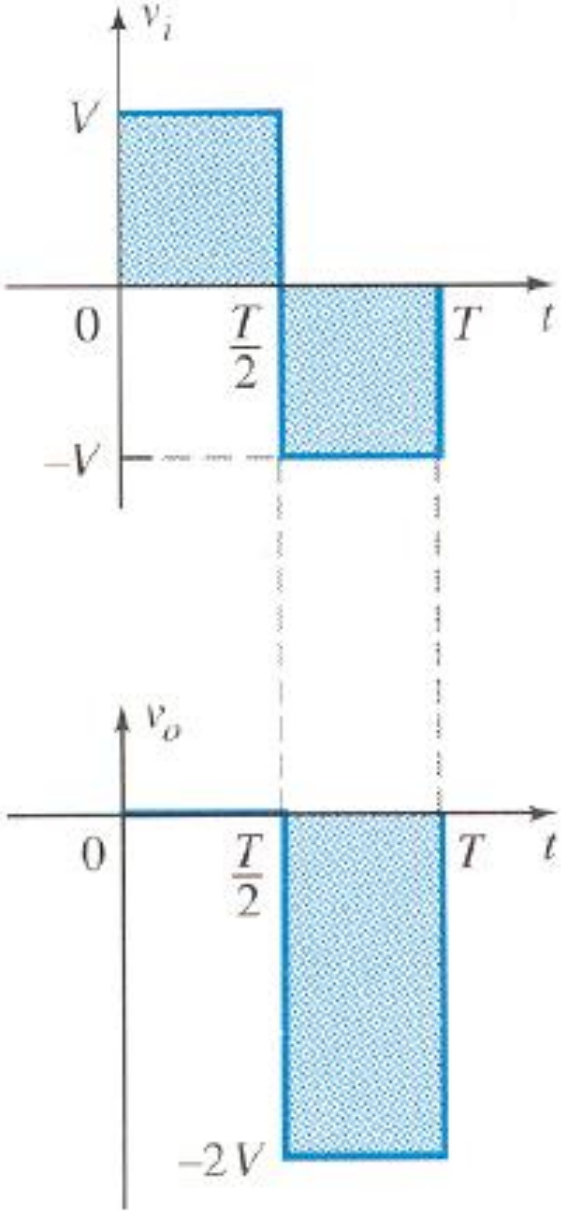
Mạch kẹp – Mạch dời mức DC (Clampers)



Mạch kẹp

Bán kì âm

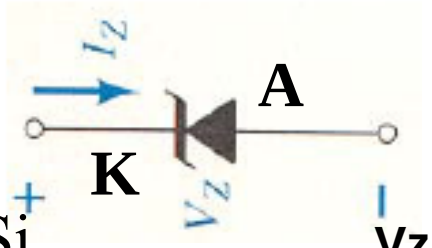
Bán kì dương



Diode zener

Cấu tạo

Thường cấu tạo bằng Si



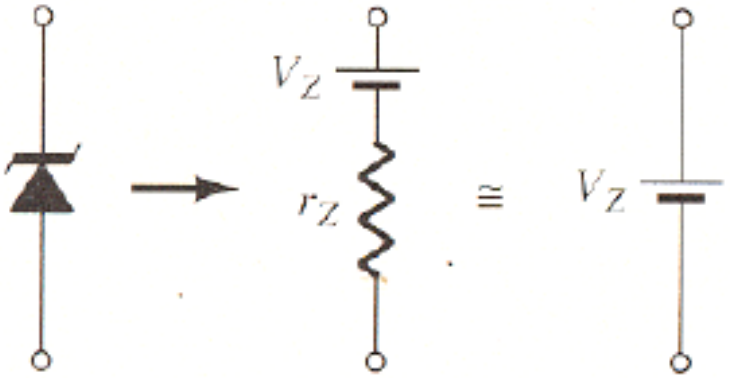
Phân cực thuận:

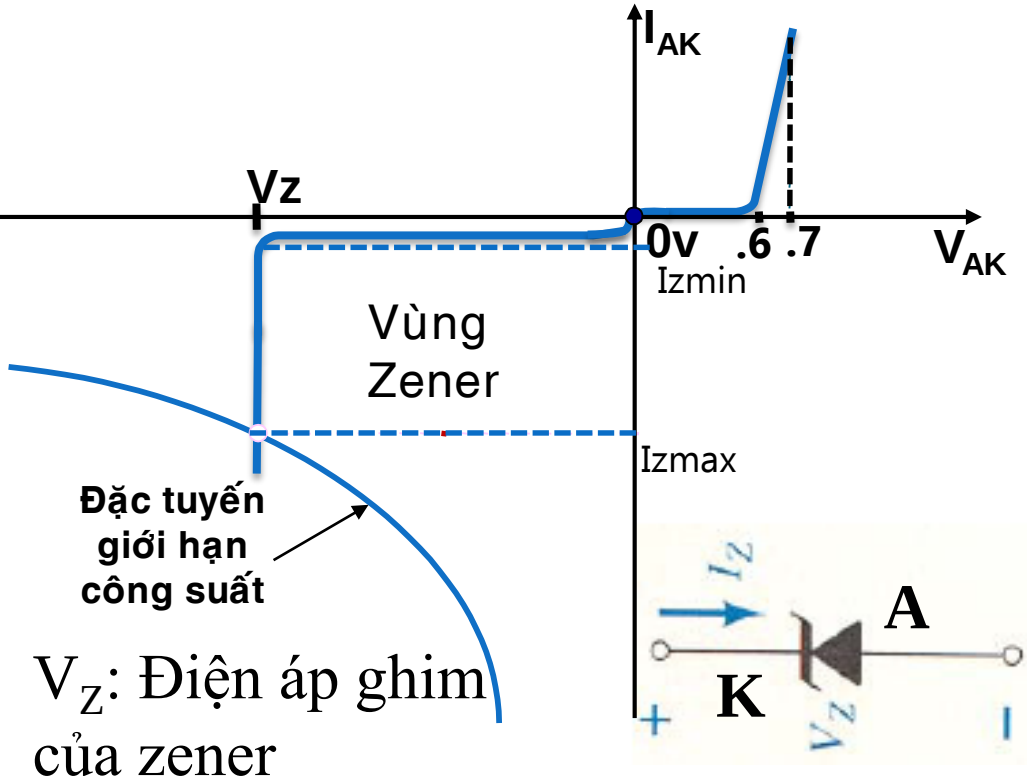
Hoạt động giống diode thường
(Vγ= 0.7V, Si)

V_Z: Điện áp ghim của zener

Diode zener

Phân cực ngược:





$V_{KA} \geq V_Z$ và $I_{Zmin} \leq I_Z \leq I_{Zmax}$: zener dẫn ngược → $V_{KA} = V_Z$, $I_Z \neq 0$

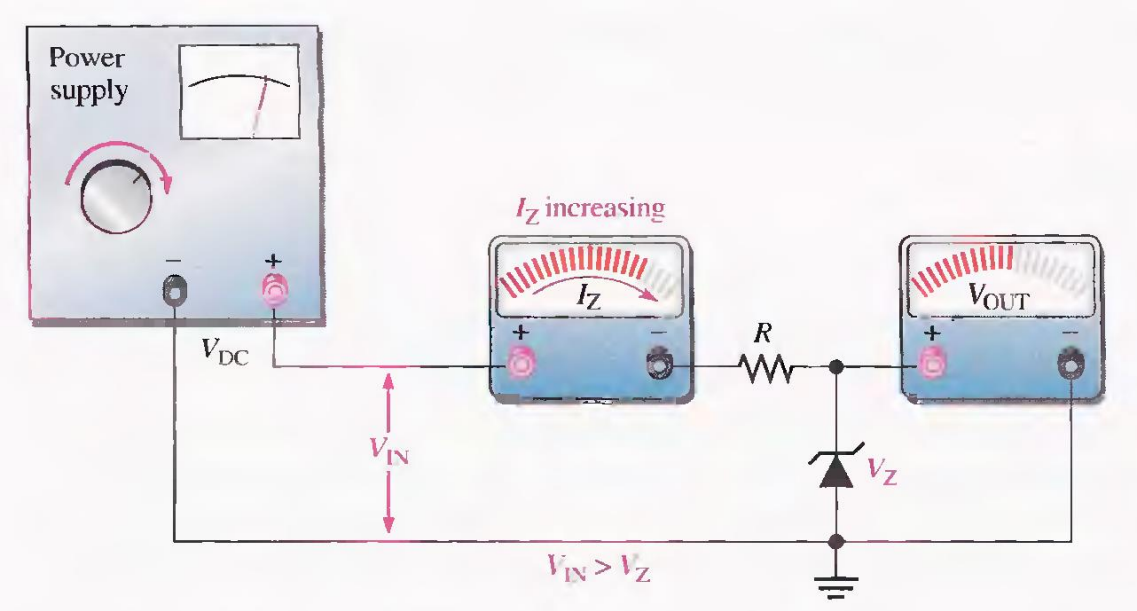
V_Z: Điện áp ghim của zener

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

→ Ứng dụng phân cực ngược làm mạch ổn áp

→ Thực tế $1.8V \leq V_Z \leq 200V$, công suất 0.25W : 50W

Diode zener - Ứng dụng mạch ổn áp

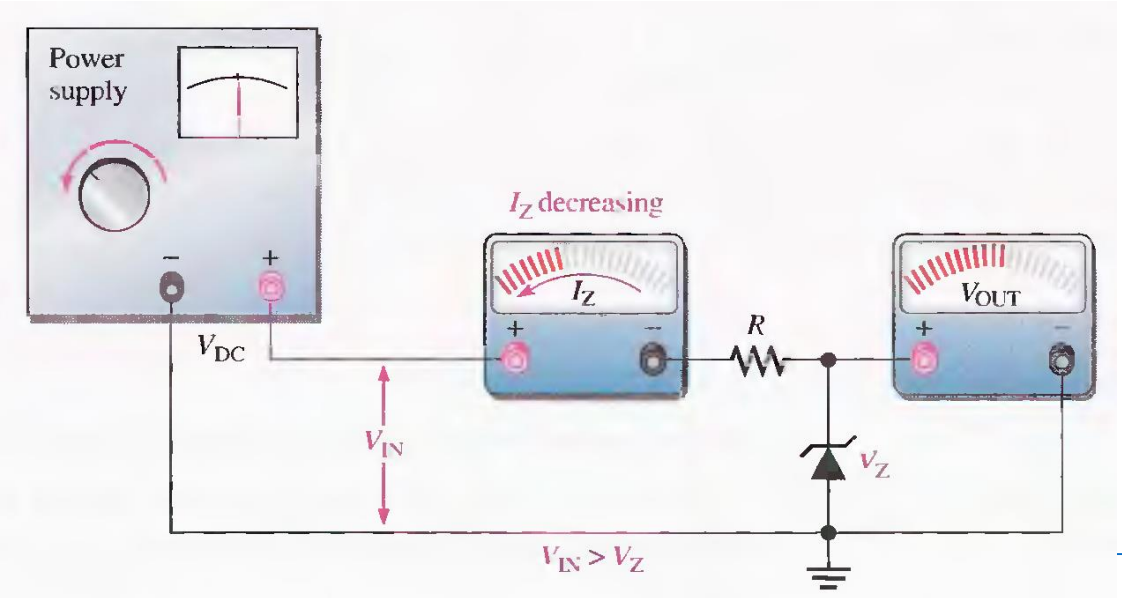


Điện áp vào tăng

$$V_{in} > V_z$$

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