L3: Diode Modles (PART .1.): (6-6-2020):-

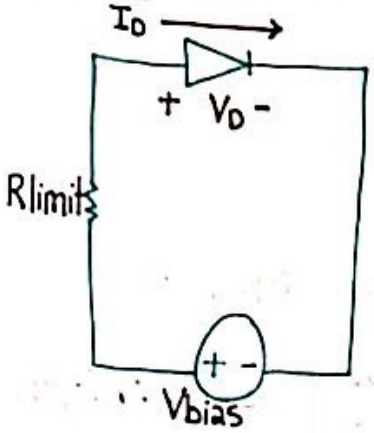
· Forward
· Reverse ← diode أول خطوة قبل هذا لتتوضيح ال

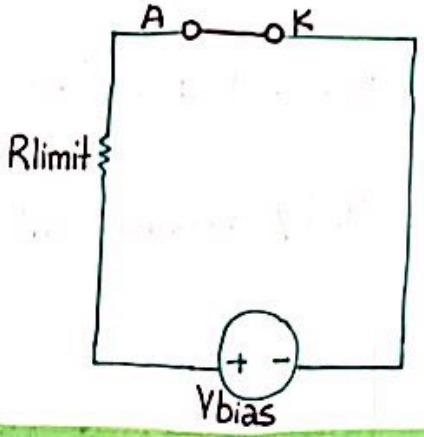
Diode: it maybe define as Forward / Reverse Bias device.

* ideal diode Model:-

1. Forward: $V_A > V_K$ → [A o—▷|—o K] we can replace it by a short circuit.

EXP: FIND V_d, I_d?





* AFTER Analysis:

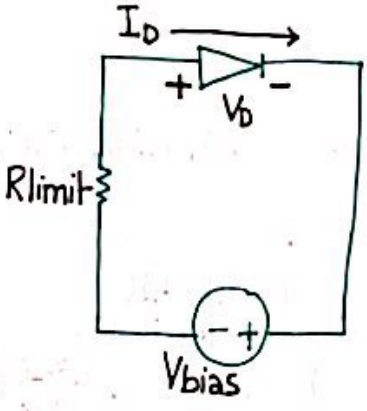
$V_D = 0$

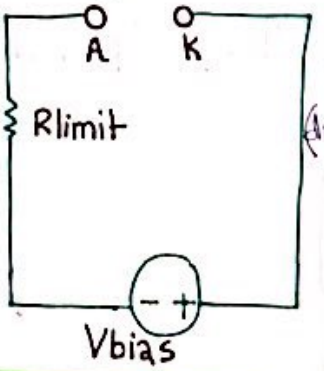
$I_D = \frac{V_{bias}}{R_{limit}}$

* Ideal diode Model:-

2. Reverse: $V_K > V_A$ → [A o—▷|—o K] we can replace it by an open circuit.

EXP: FIND V_d, I_d?





* AFTER Analysis:

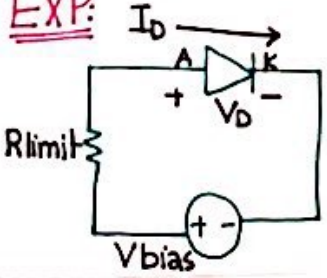
(diode) $V_D = -V_{bias}$

$I_D = 0$.

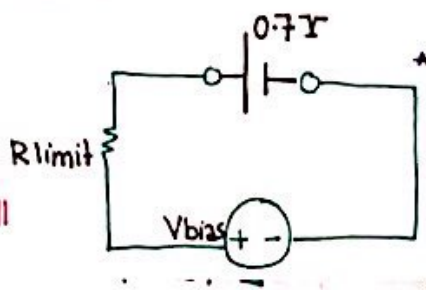
* Simplified / Knee Model:-

1. Forward: إذا كان الdiode نضع بباله بطارية تقريبًا Forward قيمتها 0.7 لـ (Si).

EXP:



we want to replace diode by a battery
We have to be carefull for the Polarity.!.



* After Analysis:

$V_D = 0.7$

$I_D = \frac{V_{bias} - 0.7}{R_{limit}}$

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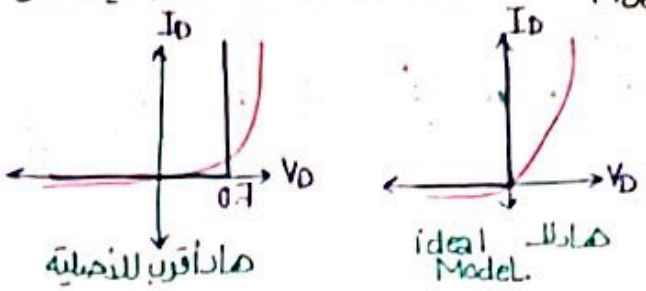
2. Reverse: we replace diode by Open circuit as (ideal Model).

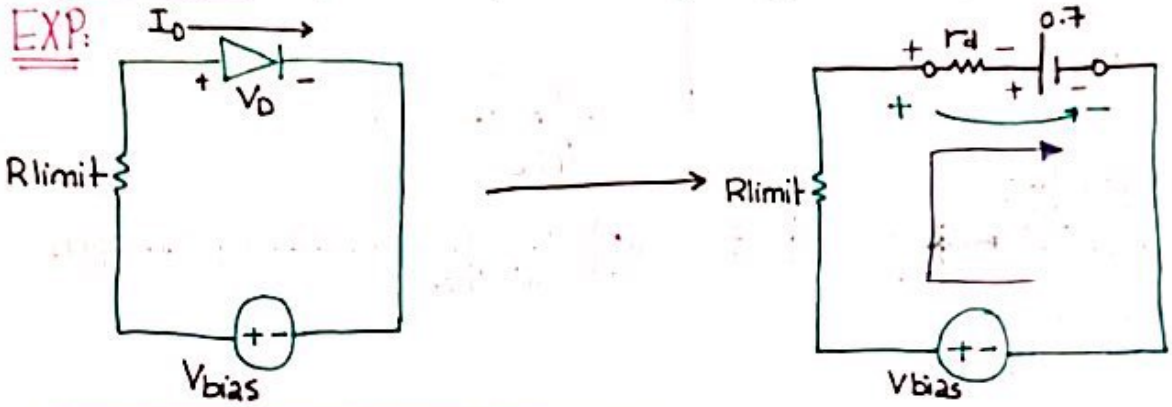
ملاحظة: Simplified Model حسن وقرب من الرسمة الأصلية أكثر



* Complete diode model: (هاداخ نخل عليها)

1. Forward: replace it by a battery with 0.7 V + Dynamic resistance.

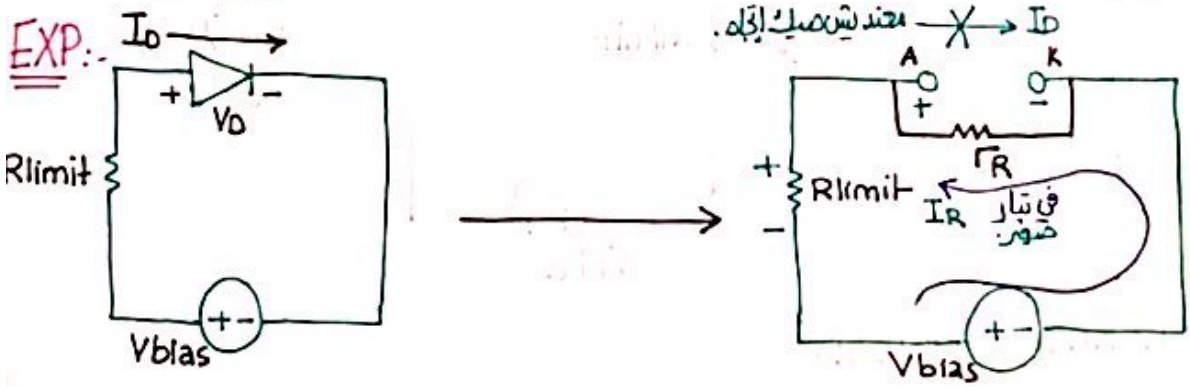
EXP:



* AFTER Analysis:
* $V_D = 0.7 + r_d \cdot I_d$
* $I_D = \frac{(V_{bias} - 0.7)}{(R_{limit} + r_d)}$

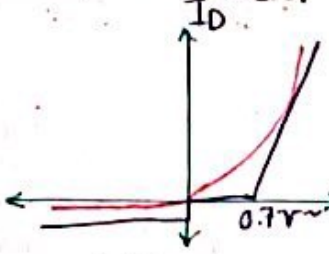
2. Reverse: replace it by Open circuit + reverse resistance with high valu

EXP:-



* AFTER Analysis:-
* $V_D = -V_{bias}$ (تقريبية)
* $I_d = -I_R$

ملاحظة: ال Complete Model اقرب أكثر من ال diode.



2.

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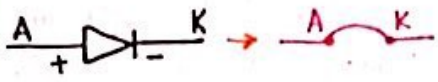
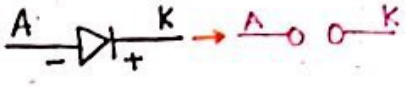
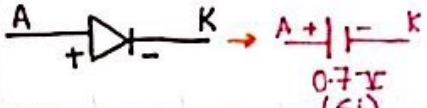
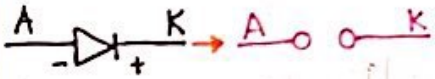
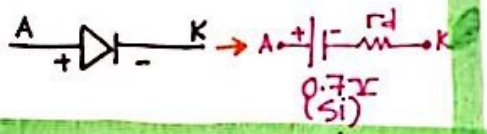
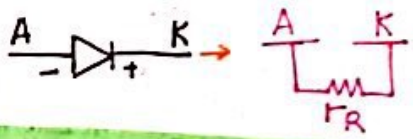
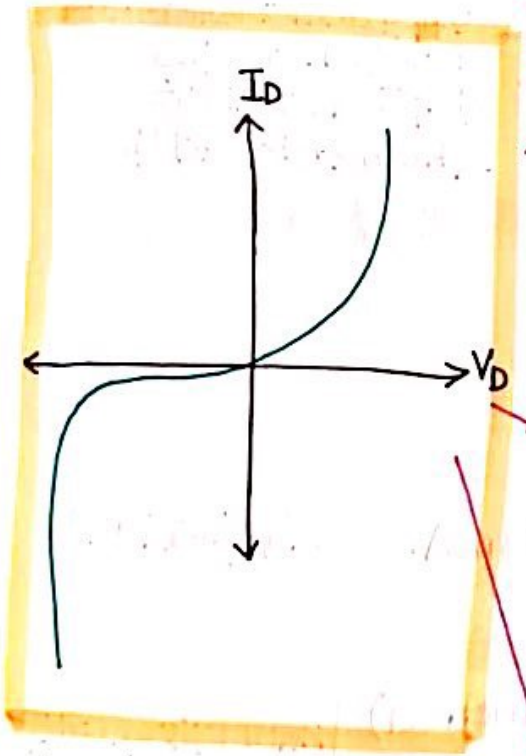
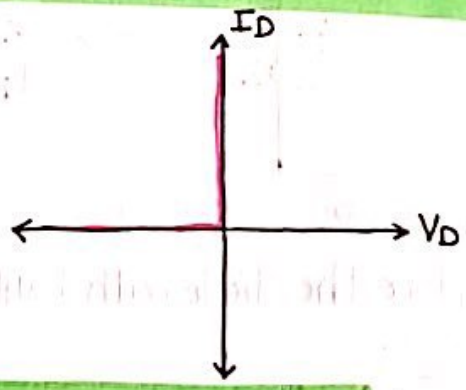
Diode Model

*تلخيص كامل للـ 3 أنواع :-

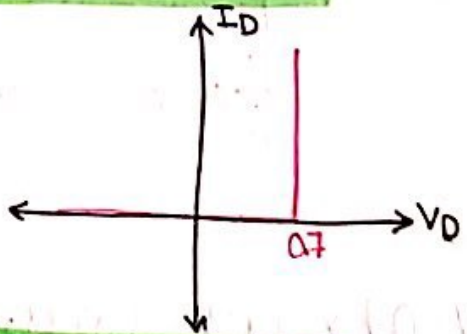
	FORWARD	REVERSE
Ideal		
Practical / Knee / simplified piecewise linear.		
Complete		



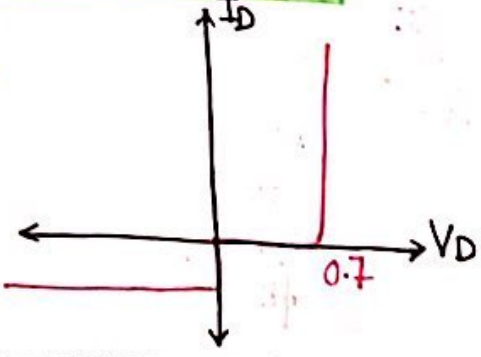
1. Ideal:-



2. Knee:-



3. Complete:-



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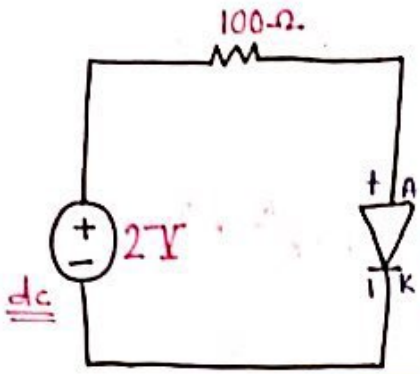
* EXAMPLE:- FIND Q-Point (I_{DQ} & V_{DQ}) (نقطة الحل)

a. Use diode ideal Model.

b. Use practical diode Model.

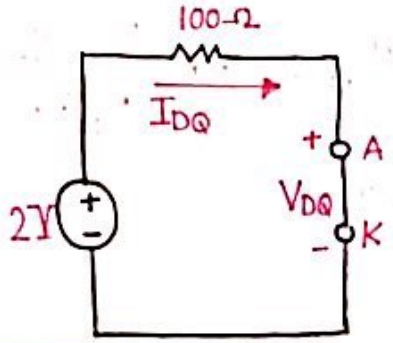
c. Use exact model.



ملاحظة: لو بدي اختار أنا أي طريقة استخدمها إذا كان الـ bias أكبر بكثير الفرع الأول =7V والثاني 70mA و63mA وهنا الديود مش كتير 10% فالتالي إذا الـ bias أكبر. 10 أضعاف من 0.7V الـ diode ساعتها الـ voltage أفضل ideal إذا لا نستخدم الـ practical.

Solution:

a. Diode is Forward Bias (ON, since $V_A > V_K$), so we'll replace it by a short circuit.

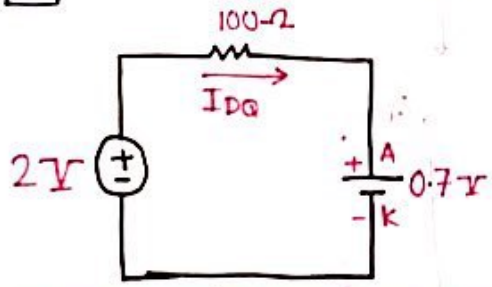


$\longrightarrow V_{DQ} = 0V = V_{AK}$

$I_{DQ} = \frac{2}{100} = 20\,mA.$

(في هذه الحالة المصدر الجهدي هو عبارة عن dc وليس ac ولكن إذا كان ac لازم أحني بالـ Reverse + Forward).

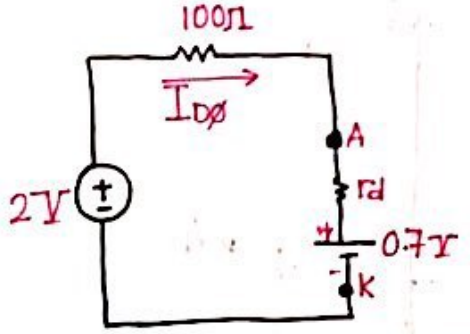
b. Replace the diode with buttery = 0.7V.



$\longrightarrow V_{DQ} = 0.7V$

$I_{DQ} = \frac{2-0.7}{100} = 13\,mA.$ (الحل أدق بكثير).

c. buttery = 0.7V + rd. (as exact → as iterative method)



$\longrightarrow V_{DQ} = 0.786V.$

$I_{DQ} = 12.14\,mA$

بدنا خذ مين أفضل الـ ideal أو الـ practical بالنسبة للـ exact method

$\frac{20}{12.14} = 65\%$ error

$\frac{13}{12.14} = 7\%$ error أفضل

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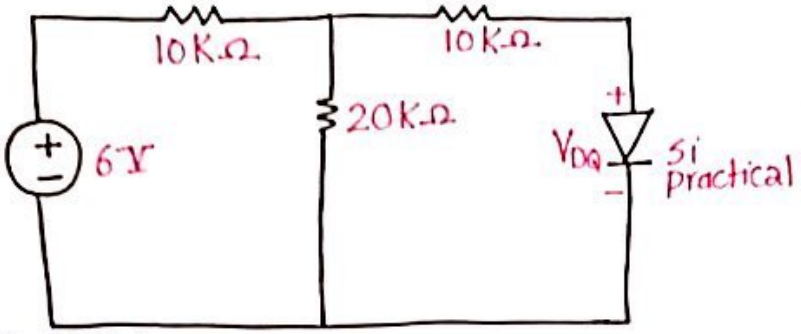
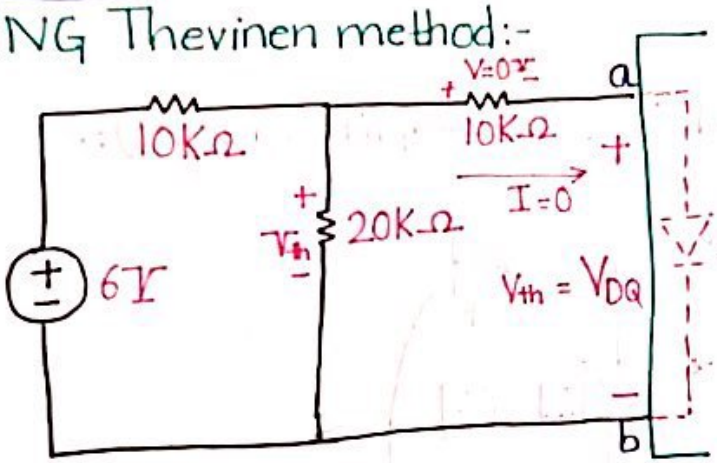
* EXAMPLE: FIND Q-Point (I_{DQ} & V_{DQ}):-

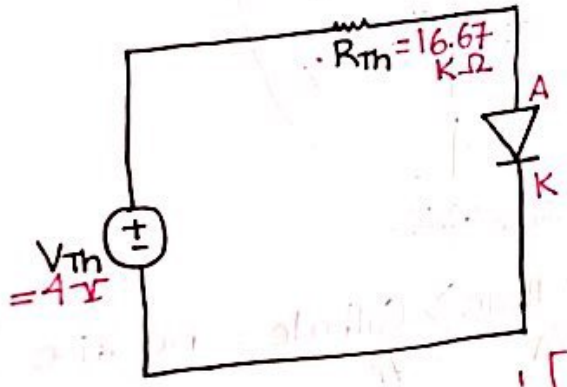


SOLUTION:

USING Thevinen method:-

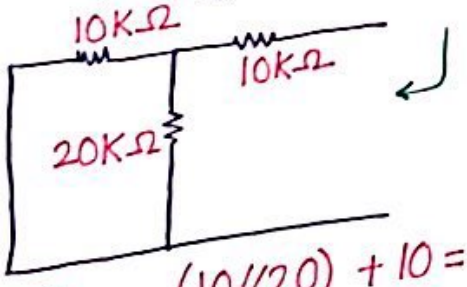


هي طريقة وين مابدي أوجد الـvoltage بشيل الـ device وبوصلها بوخذ أسهل مسار.



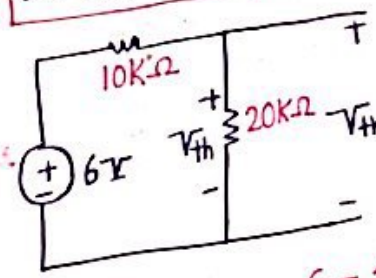
1. Rth

(Voltage source be as a short circuit)



$R_{th} = (10 // 20) + 10 = 16.67\ K\Omega$.

2. $V_{Th} = V_{DQ}$



$V_{th} = \frac{20K}{20K+10K} \cdot 6 = 4V$

.5.

.5.

.4.

from slides

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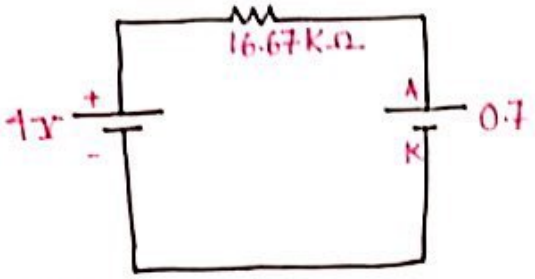
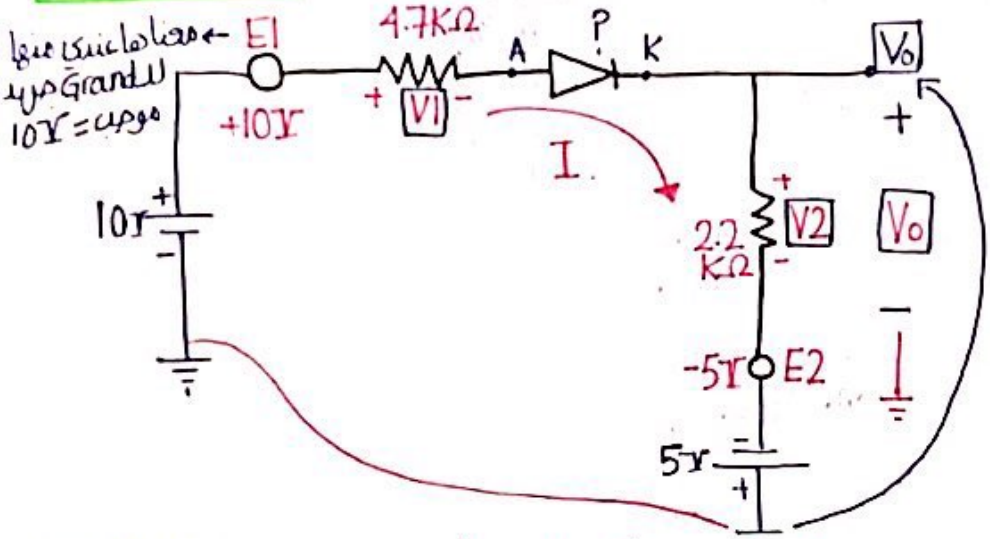
USING "Practical Method":-



$V_{DQ} = 0.7V$.

$I_{DQ} = \frac{1-0.7}{16.67}$.

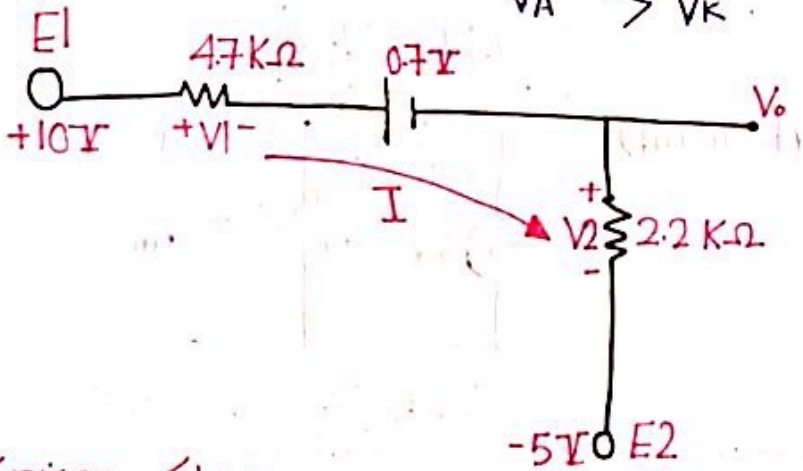
*EXAMPLE:- FIND I, VI, V and Vo (USE Simplified Model):-



SOLUTION:

Anode For diode has a positive voltage > Cathode is negative. (Forward diode)

$V_A > V_K$.



KVL: $\sum rises = \sum drop$

$10 + 5 = I*4.7 + I*2.2 + 0.7$

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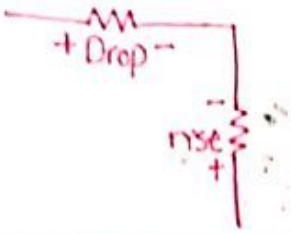
(KVL):- $-10+1.7I+0.7+2.2I-5=0$

$(-15+0.7)+(1.7+2.2)I=0$

$I = 2.07\,mA.$

---

* KVL ⇒ Σ rises = Σ drops



$V1 = IR = 9.73\,V.$

$V2 = IR = 1.55\,V.$

$V_o = V_2 - 5 = 0.45\,V.$

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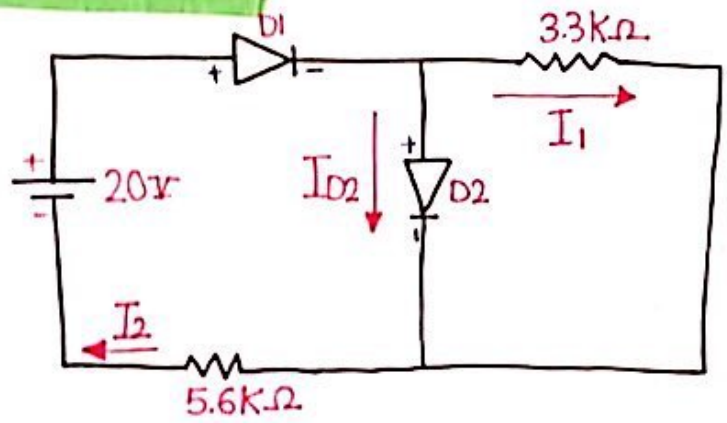
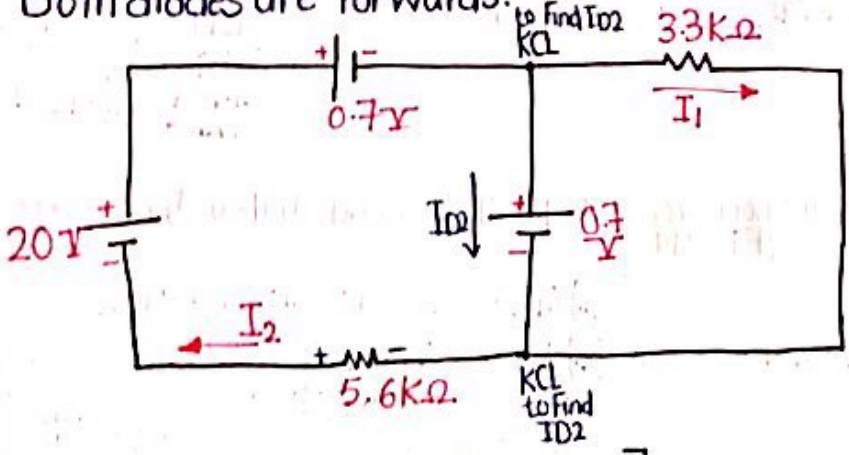
* EXAMPLE:- FIND I1, I2, I_{D2} (USE Practical Model):-



SOLUTION:

Both diodes are Forwards.



* I_1 Parallel voltage Source

$I_1 = \frac{0.7\,V}{3.3K\Omega} = 0.212\,mA.$

* KVL TO FIND I2:-

$-20+0.7+0.7-5.6I_2=0$

$I_2 = 3.32\,mA.$

* $I_{D2} = I_2 - I_1 = 3.32 - 0.212\,mA$

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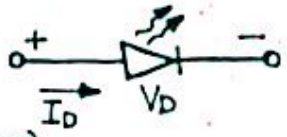
* Diode Specification sheets:-

1. معلومة عن V_D (Forward voltage)
2. أقصى تيار مسموح فيه.
3. Reverse break voltage (فولت سالب بجرب عنده).
4. Maximum Power dissipation at Specified Temperature.

NOTE: Other Kinds For Diodes:

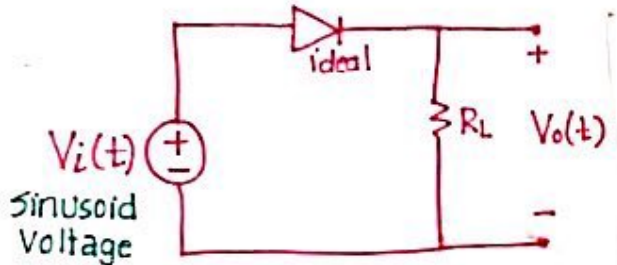
1. Zener Diode in (L6).
2. Light emitting diode. (LED) → Forward Bias يشتغل عندما يكون (2,3 V) لبنفسجي. ولها ألوان عدّة.



PART(2):- مطلوب الـ diode يعمل Function معين أو كيف نحلله Analysis.

* Diode large- Signal application:-

1. Diode Clipper Circuit.



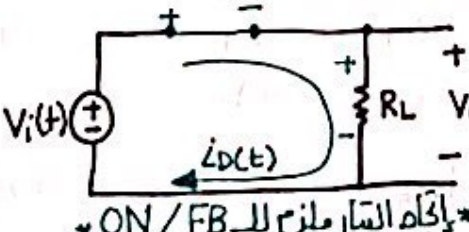
Sinusoid Voltage source (Not constant) في هذه الحالة نعتبر كإنه مفتاح الـ (diode)

Close → ON (short Circuit) / (Forward Bias) → لازم تكون V_i موجبة

Open → OFF (close open circuit) / (Revers Bias) → لازم تكون V_i سالبة

ملاحظة: يمكن وجود قطع أخرى في الدارة تخليني ما أعرف شو لازم يكون V_i ليكون الـ diode FB أو RB.

فحسب إلي راح نحله راح نفترض حل الـ diode (short circuit) ونطلع جميع قيم V_i الممكنة لحتى ما نحل KVL. (FB/ON)



* ON / FB → باتجاه التيار ملزم للـ

1. $i_D > 0$ (because it's Forward)
2. $i_D(t) = \frac{V_i(t)}{R_L} > 0$ (positive بشتغل)

$\therefore V_i(t) > 0$

ملاحظة: ممكن R_{th} تكون بعالبة لما يكون source dependent.

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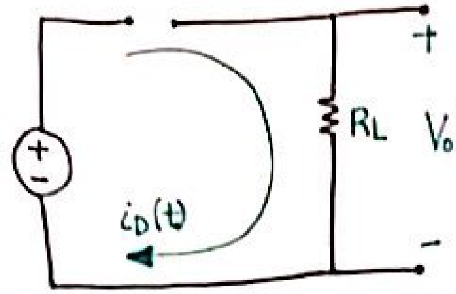
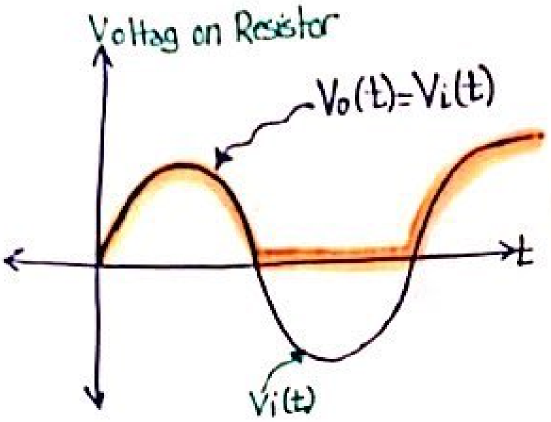
- بعدها راح نفترض كمان مرة حل الـ diode ← OFF / (open circuit).

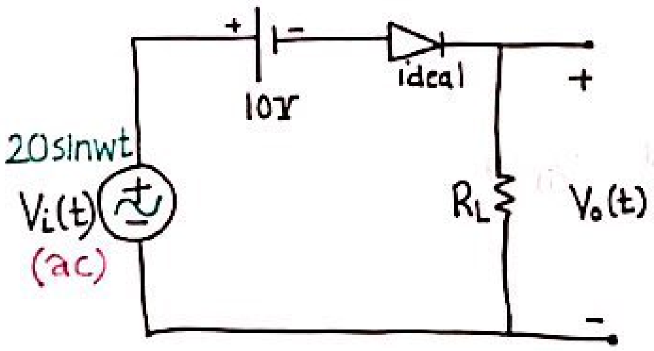
- When $V_i(t)<0$, the diode is off and $V_o(t)=0$.

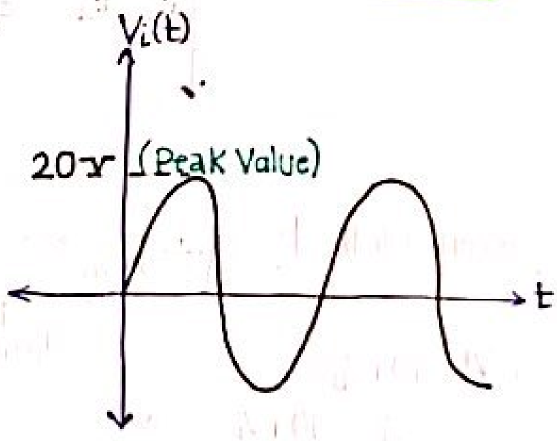




"limitter Circuit / Clipper Circuit"
"Rectifier (AC to DC convertor)"

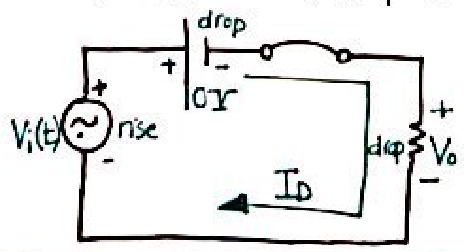
* EXAMPLE:





1. Assume diode is ON / FB:-
USING Ideal Model: (replace it by short circuit):-

ملاحظة/لحل إشكالية تحديد RB/FB نفترض ونعوض بقيم تقطع القيم لـ V_i التي نعمله بأحد الأنواع.



→ KVL:

$V_i = 10 + V_o (i_D \cdot R)$

$i_D = \frac{V_i - 10}{R} > 0 \rightarrow V_i - 10 > 0 \rightarrow \boxed{V_o = V_i - 10}$

$\boxed{V_i > 10}$ Diode is ON.

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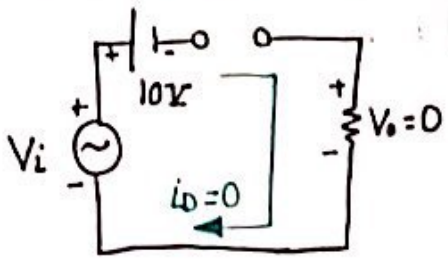
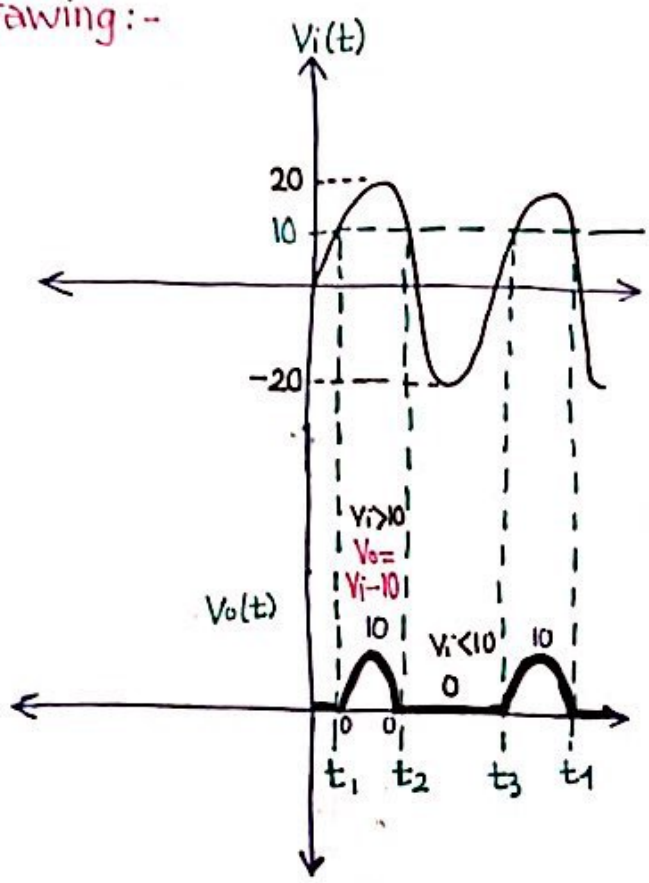
2. $V_i < 10$, Diode is (OFF) and (Open Circuit):-



$V_o = 0V$

Drawing :-



Second Method: V_D — + V_D − drop — لازم الكرنت يكون سالب في حالة الـ Open إذا بدي أطلع فيها. $V_D \leq 0$

KVL: $10 + V_D = V_i$

$V_D = -10 + V_i$

$V_i < 10$ Diode OFF.

$V_i > 10$ Diode ON.

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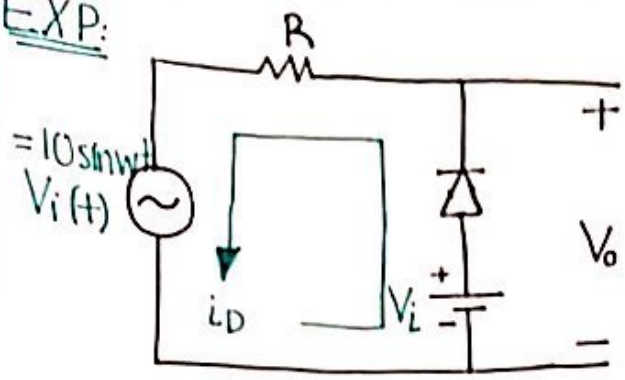
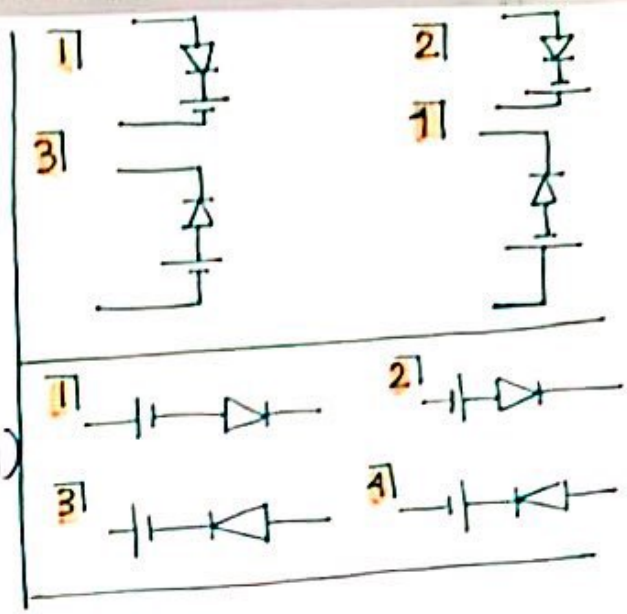
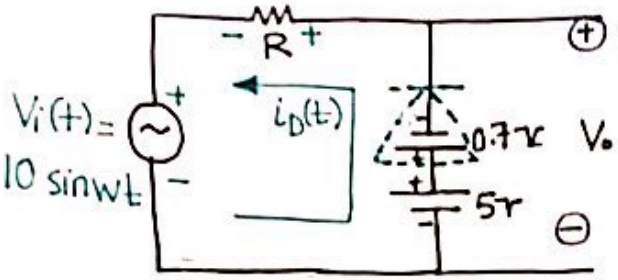
EXP:





SOLUTION: (USING Simplified diode Model)

1) Assume diode is ON/FB.



KVL: $5 = 0.7 + R.i_D + V_i(t)$

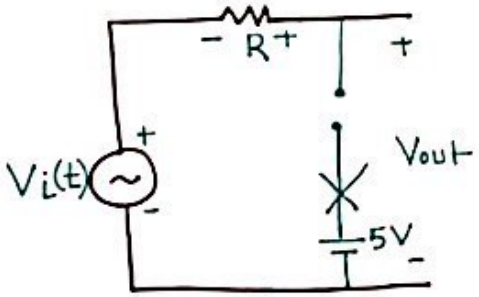
$R.i_D = 4.3 - V_i(t)$

$i_D = \frac{4.3 - V_i}{R} > 0 \rightarrow 4.3 - V_i(t) > 0 \rightarrow V_o = 5 - 0.7 = 4.3V$

$V_i(t) < 4.3V$ (FB)

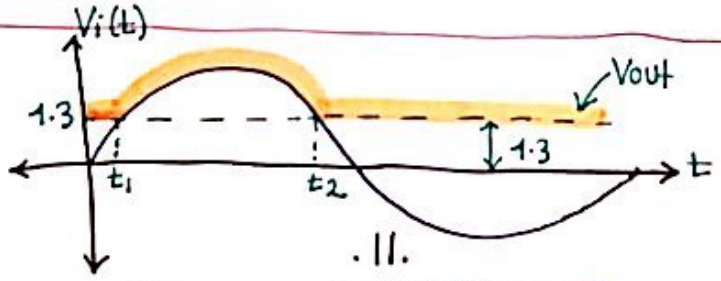
2) Diode is open:- $V_i(t) > 4.3V$

$V_{out} = ?$



$V_{out} = V_i$

Drawing



NOTES:-

1) $V_i(t) < 4.3 \downarrow V_o = 1.3$

2) $V_i(t) > 4.3 \downarrow V_o = V_i$

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