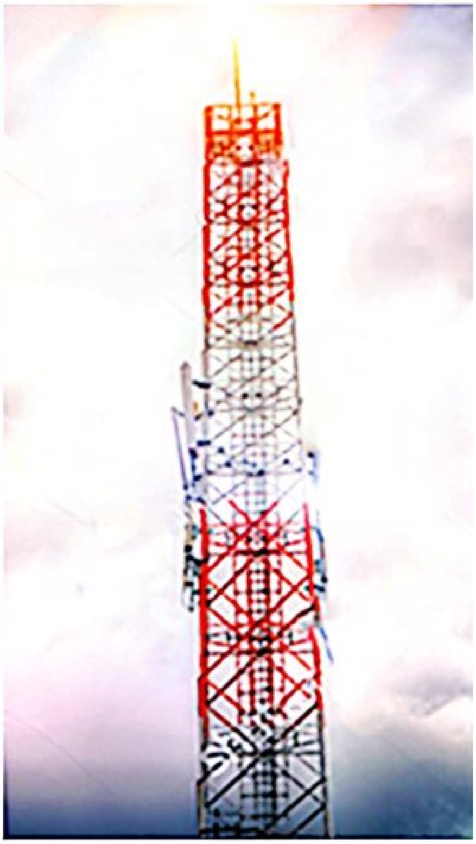
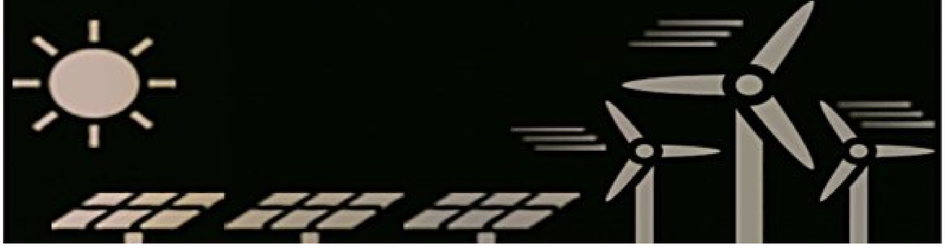
Communications Circuits

Dr.Jammal Rahhal

By: Anoud Al-Hallaq



powerunit-ju.com



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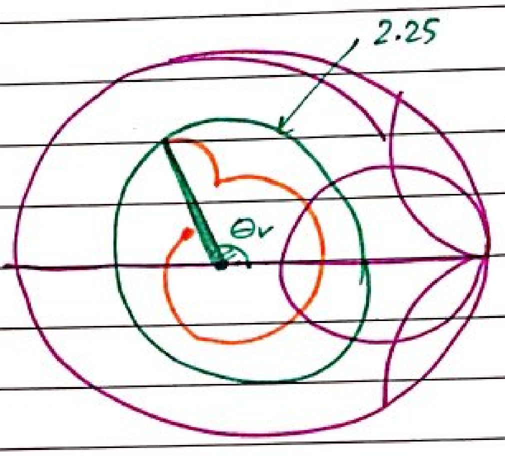
2018

COM CKT 31/1 Wed

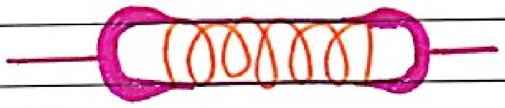
Component that we use → R, L, C
→ Transistor



$\Gamma = |\Gamma| \angle \theta_r$

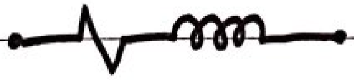
System → Amplifier
→ Mixer
→ Filters
→ oscillators.

* R :-

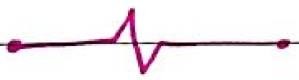


low freq resistor

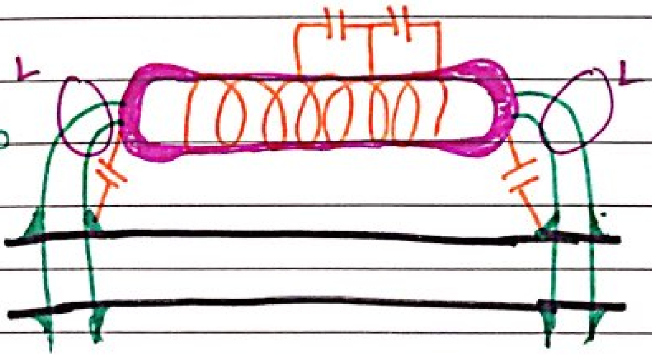
لـ مصنوعة من مادة سيراميك
بورسلان .



simplest model



مقاومة ملحومة
ع بورد



* spirel بين لفة وثانية في (C).

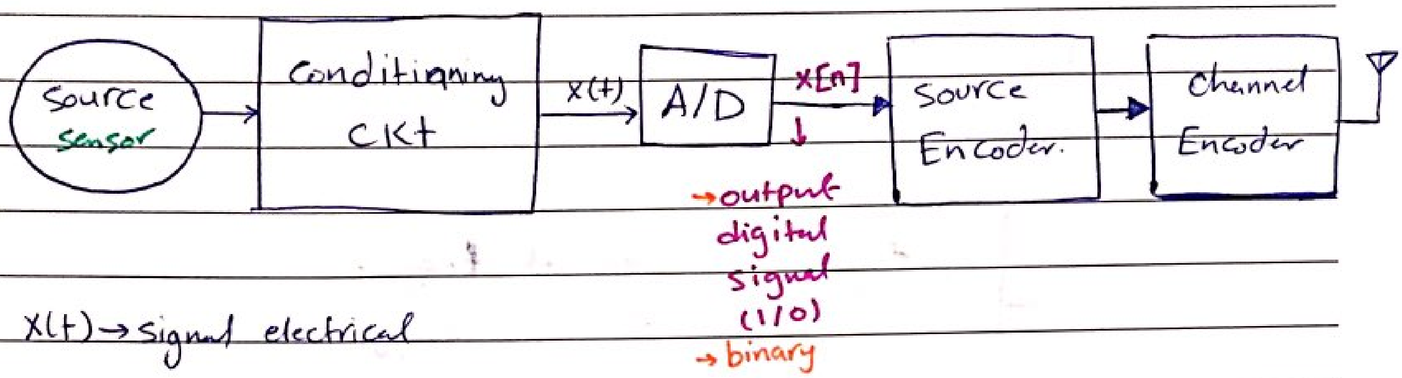
* - في drop volt في عندي capacitance

* prepterpation analysis

* لازم اعمل لل design (prepterpation) عشان اعرف اذا صار في تغيرات بعده عندي صح (شغال).

* potenitial barier. → عبارة في فرق بين volt
between 2 material.

5/2 MON



x(t) → signal electrical

A/D → fine quantizer

⇒ Base band Signal. ← إي: بتعمل loss

⇒ Source Encoder ⟶ compression.

⇒ freq → something repeated it self

$\lambda f = u$ (propagation speed).

$\lambda \uparrow$ in low freq.

⇒ $\lambda \gg$ size of component. ⇒ low freq Model.

R, C ⇒ pure

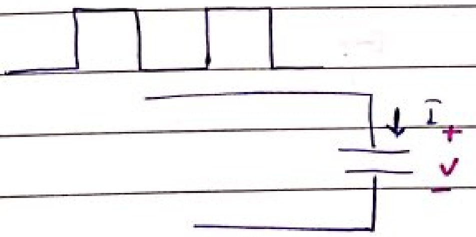
{1:50 / 1:100} ⇒ $\lambda \sim >$ size ~~(comparable) (comparable)~~

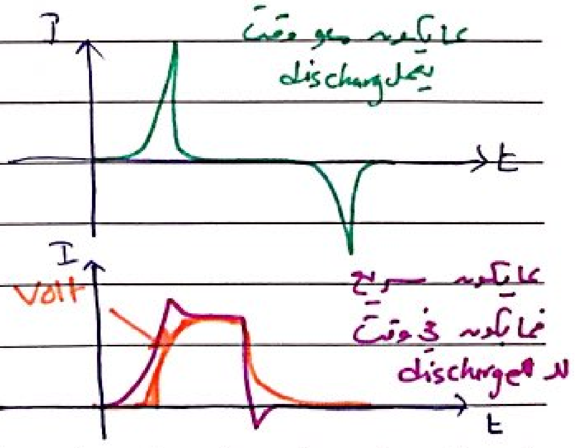
⇒ $\lambda \sim$ size (compared) ⇒ high freq Model

باخذ بعين الاعتبار physical path

* في حال ال System ال low freq هل اكل علي اي ــــابة *

100 Mbps → square signal.

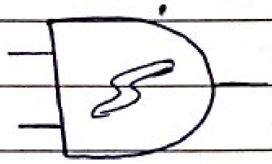




$P = VI \cos\Theta$

$\boxed{3}$ * V and I phase shift not 90°

$P_{heat} \propto f^2$



~~schmitt trigger~~
Shmmit trigger

noise margin → (0.8 - 3.6)

signal

high → low.

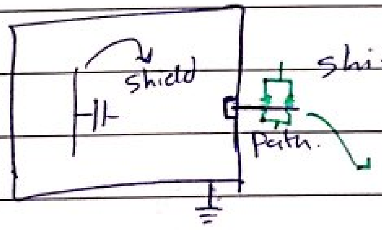
schmmit → عادة high وتنزل لـ low
ما تنزل بتضل high.

⇒ Clock speed eye → 120 msec. (8 frame / sec).

⇒ clock speed ear → 50 HZ

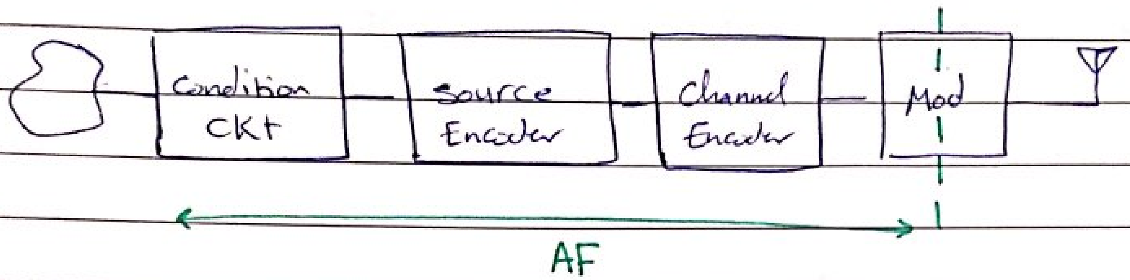
⇒ heat → noise.

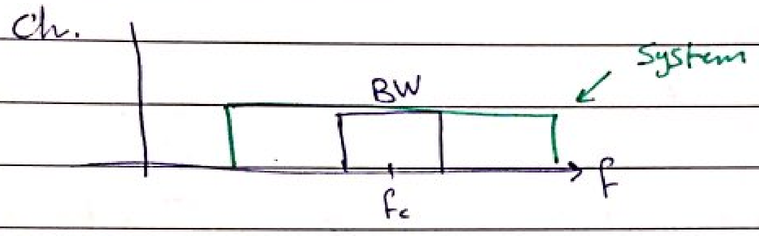
s/c ← electrical field ←
s/c magnatic " ←
بدي موصل ~~جيد~~ جيد



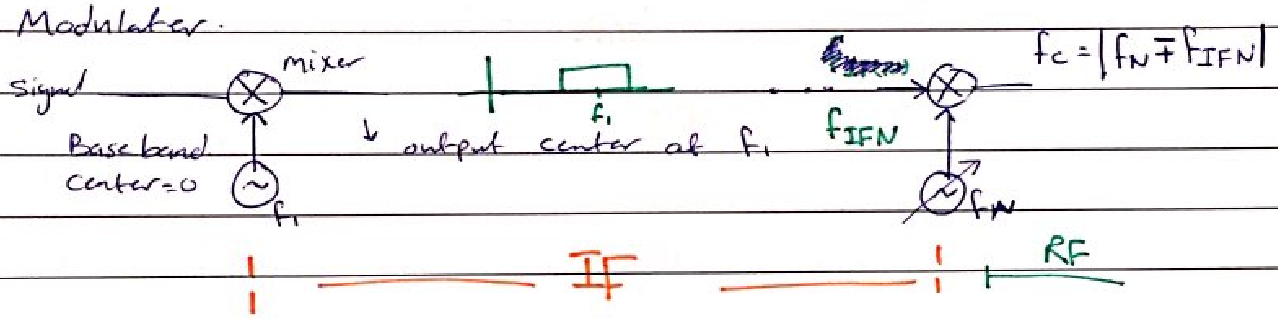
shield → لازم يكون grandend.

7/2 Wed



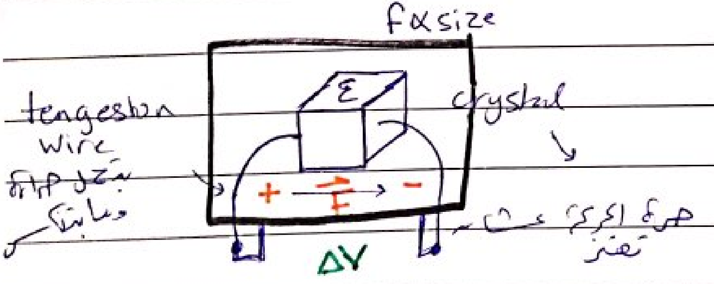


Modulator.



OSC with feedback → ~~[illegible]~~ phase locked loop. ① Stable due to temprature.

↳ phiscal quantinty



substrate → قاعدة إلي بنبني عليها structure

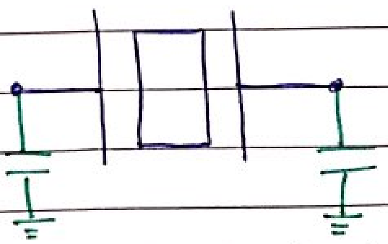
damping → equivalent q Q↓ → error. بيعرفنا

oscilation → بتحدد الابعاد

current → Ac current.

* temprature compensation.

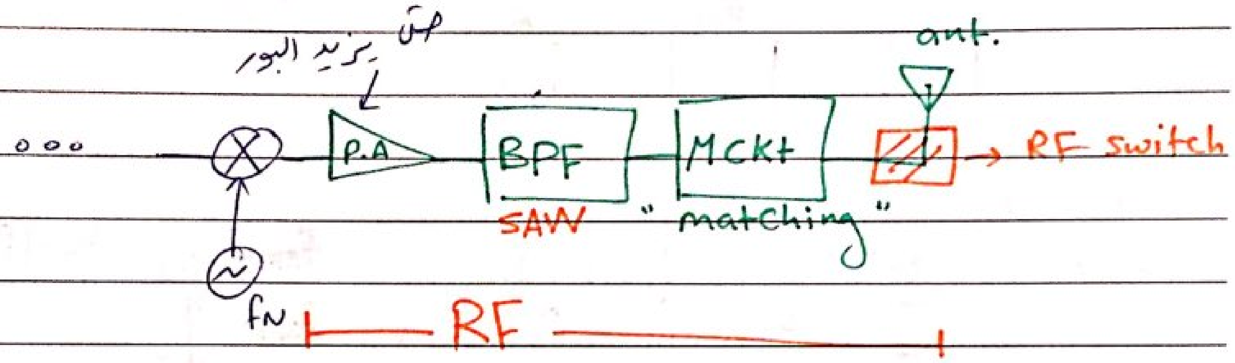
2cap ← بس لقاعدها ~ علشان ~~[illegible]~~ [illegible]



crystal → عاتكم لازم ما تزيد درجة الحرارة عن 160.

* Junction temp

* RF stage → ترددها عامل التردد
في antenna
→ اعلى frequency



* اذا كان linear ← ميطلعش Harmonic

* tunaple Bandpass → big issue.

* matching ckt → directional coupler.
→ feed back system

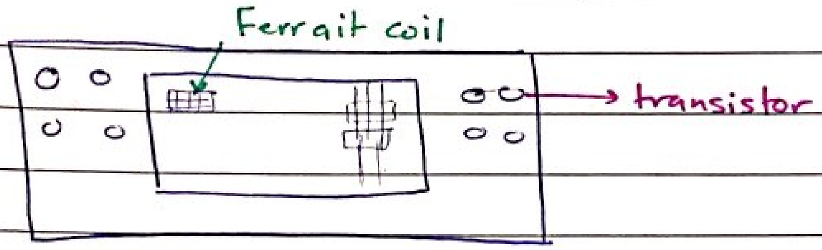
* Reviarce direction → isoulation. (self interference).

12/2 MON

⇒ Magnatic memory :-

transistor → drivers → تحكم

memory ال



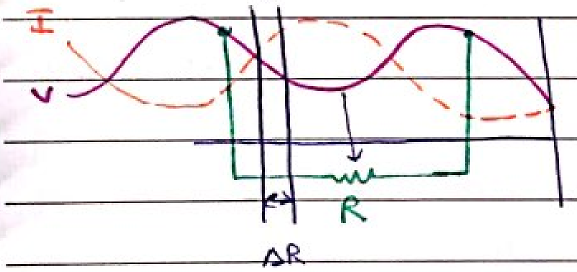
* power supply → f = 0.

⇒ RF → high frequency ~~on~~ 1KHZ not high freq.

⇒ λ >> component => component تقطع عن طول اكبر

⇒ lumped component => λ < component.

standing wave.



↳ lumped element. مكونه اكبرها

⇒ diode → nonlinear.

In high freq → يختلف تعامله ⇒ different type of diode. (pin diode)

تقليل ل capacitance ← مساحة مقطع كبير ← بقدر تيار اعلى.

. at low freq → component use as lumped ~~elem~~ elements.

transistor is a Switch

HW # 1 :

How to use capacitance as inductor ?!

↳ using stup

Basic Components:

⇒ RF Modeling of Basic Component :-

* R :-

$$\boxed{R = \frac{l}{\sigma S}}$$

S = مساحة المقطع (area)

σ = conductivity .

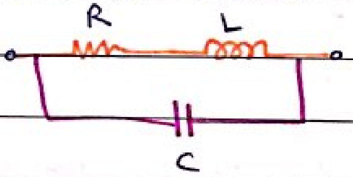
مثلاً $\overset{R,\,L,\,C}{\overline{\quad\quad\quad}}$ σ, M, ϵ

L↓ أقل ما يكون

C ⇒ drop voltage → electricfield (+, -)

(capacitance)

↳ not in series.



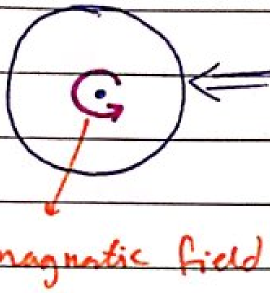
$$C = \frac{\epsilon S}{d}$$

$$L = \frac{M l n}{S}$$

⇒ graphine ⇒ يحجب مصدرات الموجه

ع شكل shield

↳ use a super conductor

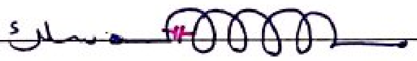


⇒ μ permeiplity → كل ما يكون مسموح يتحرك باي اتجاه.

⇒ ferromagnatic material → μr high.

⇒ dia magnatic material → ما بتتحرك مثل الماء

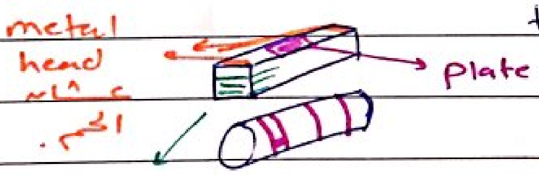
⇒ Inductance بتزيد ⇒ اذا لفيت السلك.
Capacitance بتزيد



* طرق تصنيع الـ D8 R

material block of material.

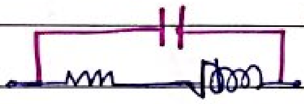
trinch خندق → spiral. عليها



أقل LC طا ~~R~~

Low freq.	high freq.

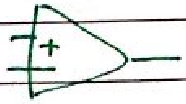
R



* حجم R ← بحدد Power desibation

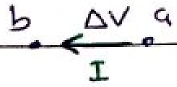
14/2 WED

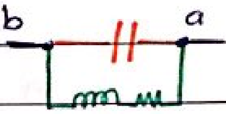
H.W. we use 2 op-amp to change the phase shift and use capacitance as inductance.



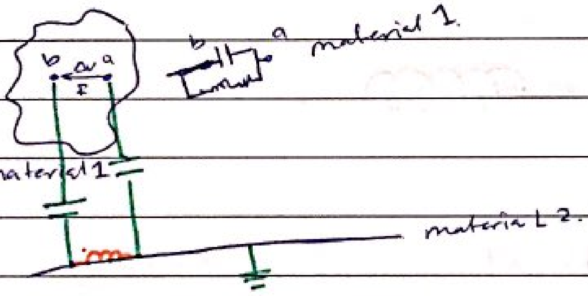
Capacitance ← ΔV عني

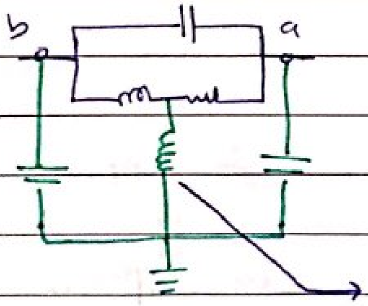
Inductor عني ← I عني





* L in serries with R.



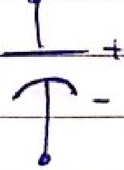


→ mutual inductance btween 2 material.

* بدي اضيف R في دائرة عند تردد عالي لازم اقلل من قيمة c و I ولازم اعزلها ←

* اذا ما قدرنا نعزلها لازم ← count it بنحسبها.

* capacitor 8∆



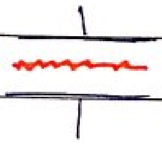
$\frac{\epsilon S}{d}$ ↑C → ↑ε

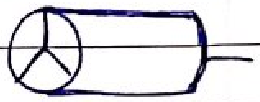
«في عازل بين 2parallel plate «ورق مغطس بالشمع».

have weak point ⇐ عا يعمور الـ C.

$\uparrow I \rightarrow I^2 R \uparrow \rightarrow$ temp↑ → C بتفجر الـ

power supply circuit → use these capacitor. connect in parallel.





E↑ → more free electrons.

داخل electron تفاعل
electric اكثر مع
field.

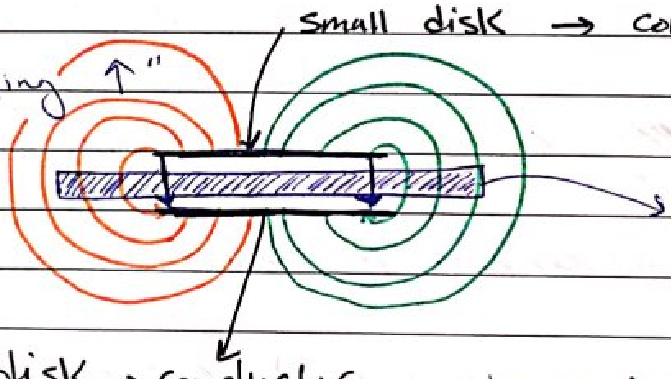
different btw Battary and Capacitor ⇒ E

↑ voltage → ↑ electric field string → ↑ force

Capacitor ckt use
- → not ↑to stored energy.
- → implement filter.
- → transfer function btw input and output.
- → non polirized capacitior.

small disk → conductor

" ↑ Sharp → fringing ↑ "

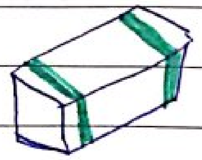


big disk ⇒ مادة سيراميك (
non polirized.

Small disk → conductor.

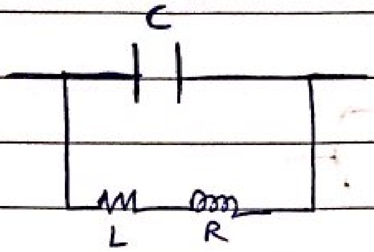
range ⇒ nana - picko Farad

Survice ~~mount~~ mount-a

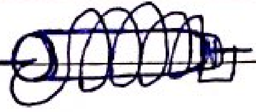


size range ⇒ 1.2 cm → 1mm

$\boxed{11}$



right rod
$M \uparrow$



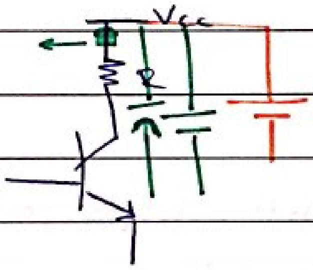
$\uparrow M_r$ → compress the size

transistor work on 1G.

ferrait

L ∝ f, عكس

Mr = 25,000 -
50,000



L → * بتصير ال impedence عالية عند high freq.

~~electro light capacitor to suppress at high frequency~~

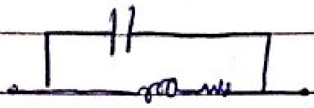
~~to shunt out / suppress / spark~~

* electro light ride → not good capacitor to shunt out. suppress on high freq.

لانو ابطئ ما بستخدمو.

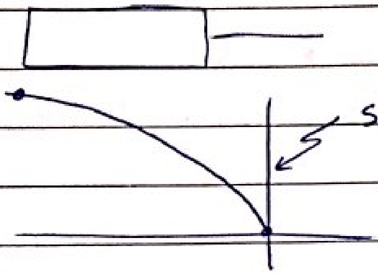
بنضيف non polrized capacitor.

19/2 MON

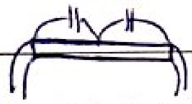


$\lambda = 3m$

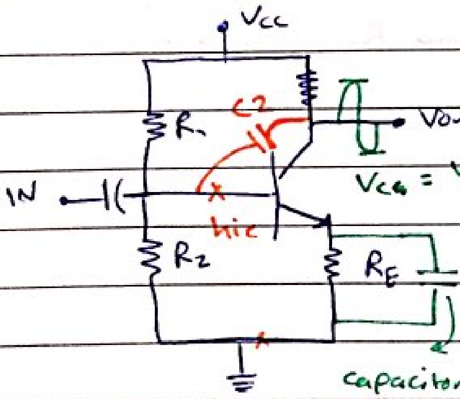
every $\lambda/2$ → بتكرر؟



* كيف بدي احكي بس واحد current. or voltage !!



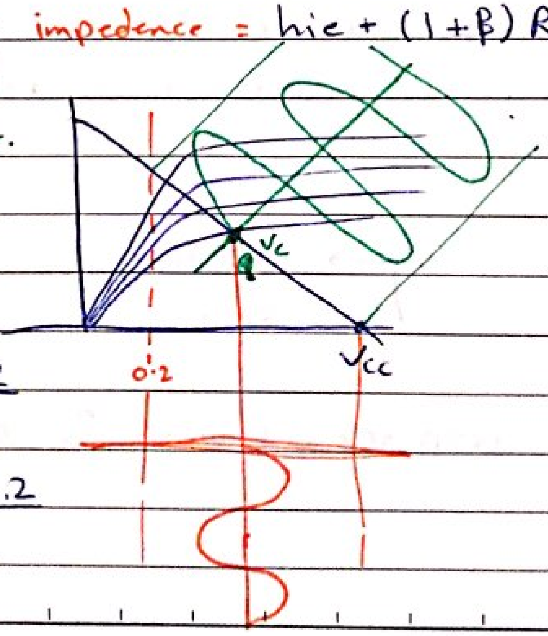
→ L ⇐ pico بعمل



$V_{CE} = \frac{V_{cc} - 0.2}{2}$

impedence $= h_{ie} + (1+\beta) R_E$

$Q = \frac{1}{3} V_{cc}$



Q point in DC.

$V_{cc} - I_C R_C = \frac{V_{cc} - 0.2}{2}$

$V_{cc} - (\beta i_b) R_c = \frac{V_{cc} - 0.2}{2}$

$$\boxed{\text{Gain for AC} = \frac{-h_{fe} R_c}{h_{ie} + (1+h_{fe}) R_e}}$$ $(h_{fe} = \beta)$

Find H module for transistor ?! ← HW2 *

shunt capacitor on R_E → increase gain → $R_e = 0$.

$$G = \frac{-h_{fe} R_c}{h_{ie}}$$

sweep → freq (from f_1 → f_2)
↳ value.

extream cases. 1 → min R_c and max R_e → min gain.
2 ↳ min R_e and max R_c → max gain.

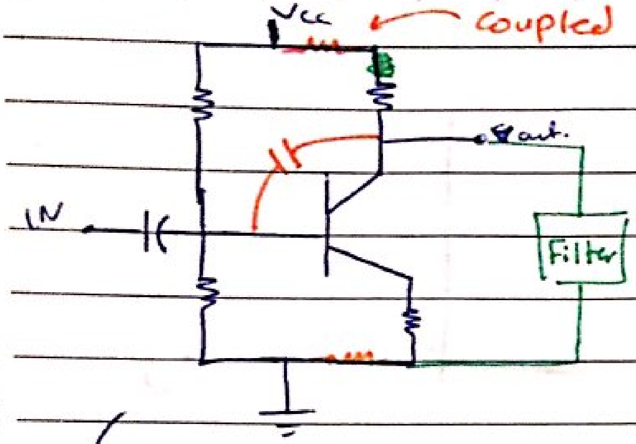
Inductor → radiation

* يخزن Induct ال signal حواليه ← بعمل mutual Inductance مع اي حواليه

* cap يخزن ال signal داخله

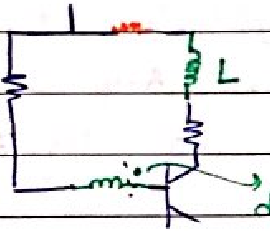
Capacitor 2 → path.
↳ oscilation.

filter ⇒ responce btween f_1 and f_2.



coupled if R and wire not ideal.

to isolate Vcc ⇒ use inductor. L



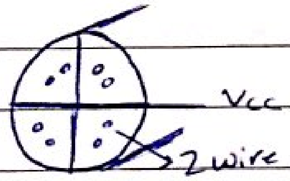
dot means coupling

Inductors
↳ use under control inviroment

*

unshielded better than shilded in out door.

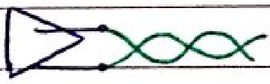
Eathernet cable.



2 wire → twisted

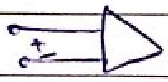
*

gnd



differential.

at Rx

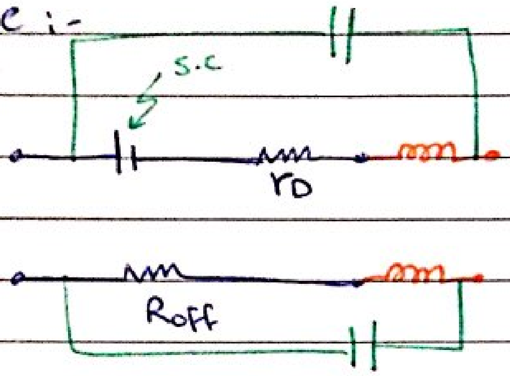


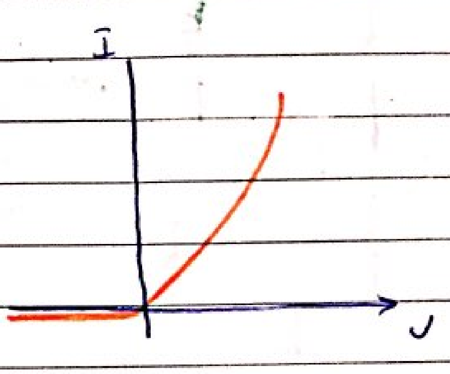
limit for voltage

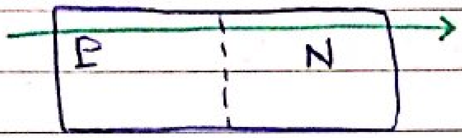
*serch Line drivier ?!

21/2 WED

* Diode :-







* مساحة مقطع بين P,N كبيرة عشان يكون تيار اكبر.

* 30Amp → 6mm - 10mm
سلك

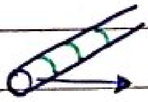
$\frac{30}{\boxed{1.6}} = \sqrt{\frac{18.75}{\pi}}$

current density→(A/mm²) الخاص AC current ← 1.6

radius = 2.4 mm

diameter = 5 mm

* area = πr^2


heat = $I^2 R$

* مساحة مقطع N اكبر من P فيمر تيار من مساحة مقطع اصغر للأكبر.

rated current 1A → IN 400 7 → 700 volt direction.
5 → use for Power supply ckt
3

peak volt = 380V

→ In Reverse :-

* ↑ current → ↑ مساحة مقطع → ↓ break down voltage
↳ capacitor ↑

* dont use in high freq → capacitor ↑ in Reverse.

* وين ماكو في تيار ماكو عندي Inductance

و وين ماكو في drop volt ماكو عندي capacitance

low current → junction area small.

⇒ diode 1N448 ⇒ use in communication. ckt

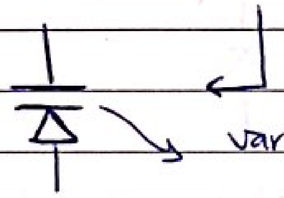
→ high freq = 1GHZ.

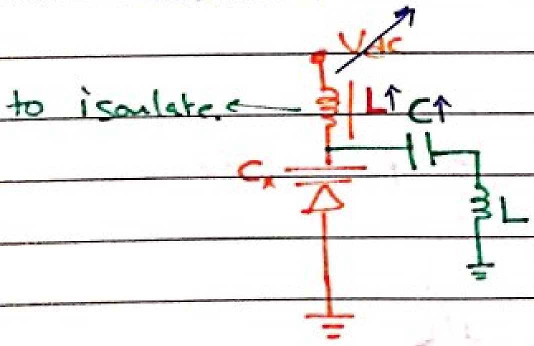
→ break down = 50 - 60 V volt

→ مساحة مقطع صغيرة

مساحة مقطع صغيرة → ↓ capacitance → diode not capacitor.
↳ Roff ↑

In Reverse → Roff. كبيرة ← بدي cap كبيرة





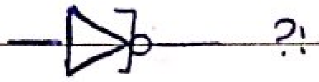
Reverse bias. for this diode.
volt = 15 - 30 V

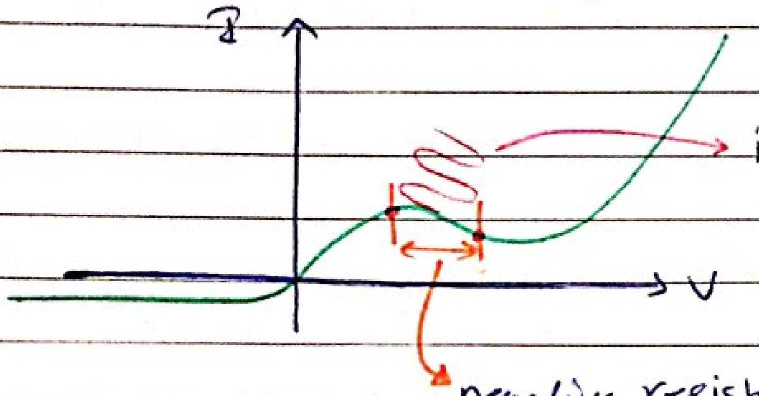
C ⇒ to prevent dc volt in this path.

L → Resonance.

* غيرت الـ doping وزدت مساحة المقطع .

* Tunnel diode

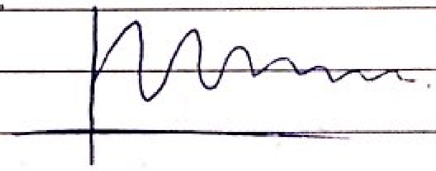




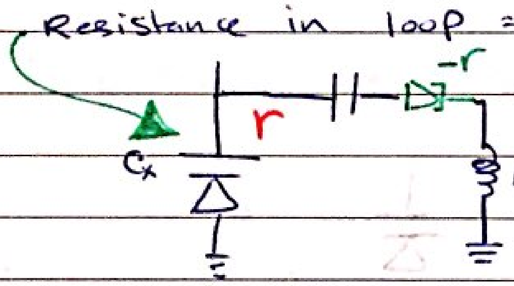
→ isoulate btween 2 point

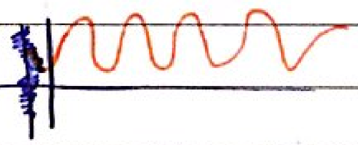
negative resistance → to do isolation.

in L → internal resistance.
and  →

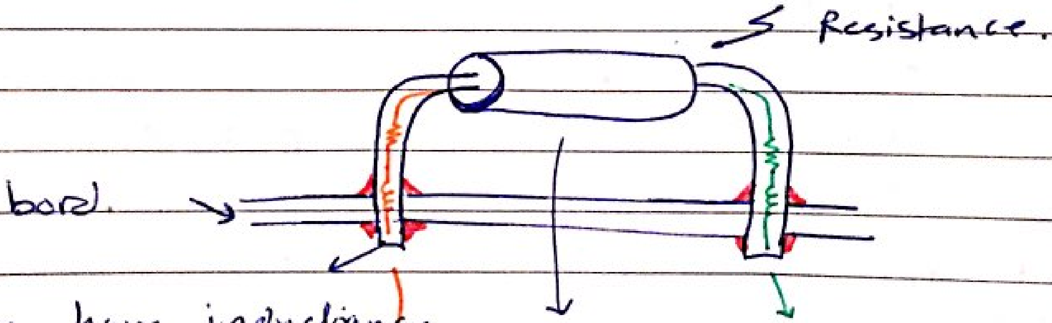


Resistance in loop = 0. →



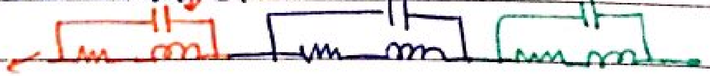


HW → look like negative ~~resista~~ impedence ckt.

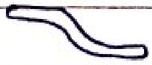


wire have inductance.

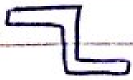
resistor لرجل ال



legs → smooth.



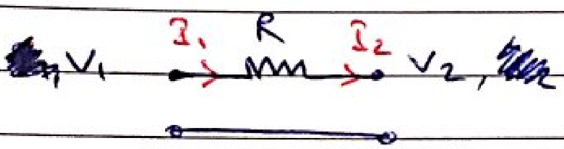
L → أقل (mutual inductance أقل)



L → أعلى θ=90°

18

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ I_2 \end{bmatrix}$$ ABCD Model.

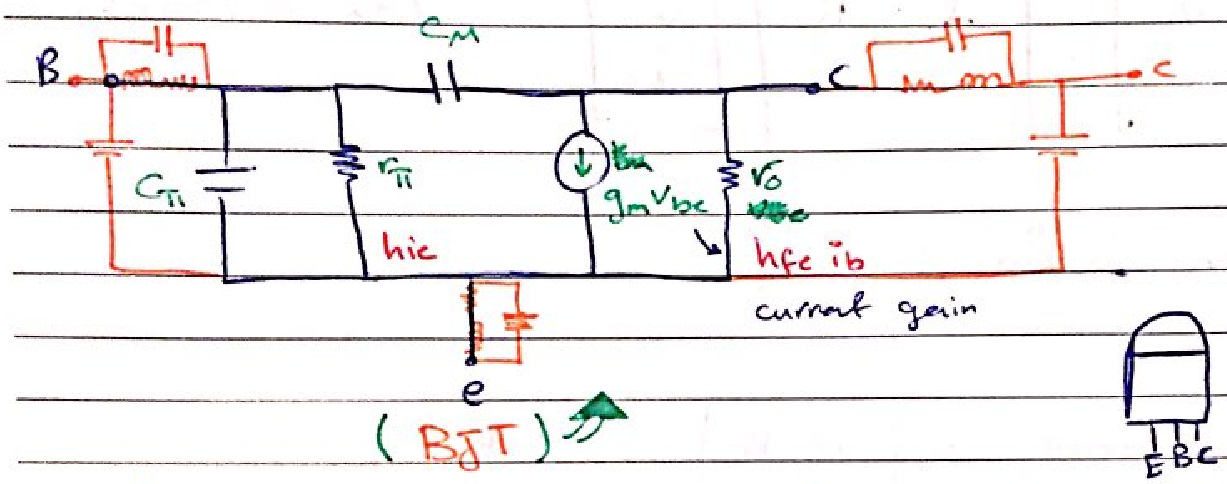


* In series → $\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & R \\ 0 & 1 \end{bmatrix}$

* In parallel → $\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ \frac{1}{R} & 1 \end{bmatrix}$

2812 Wed

H.F Transistor Model:-

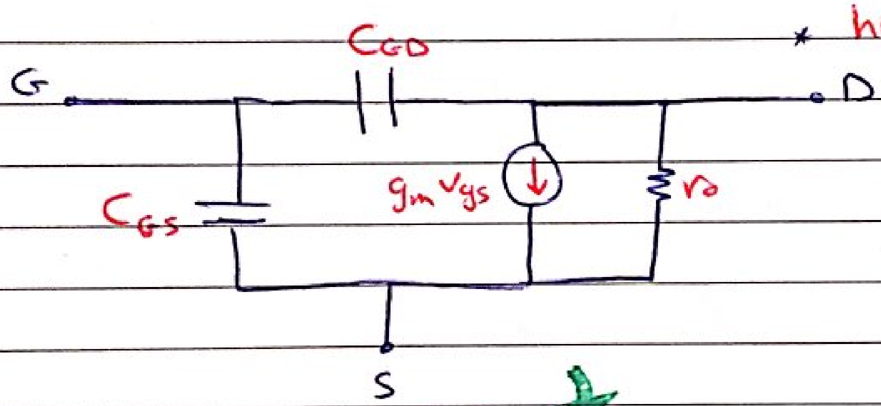


(BJT)

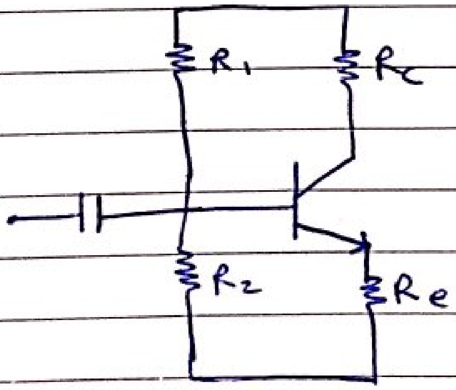
at low freq ⇒ (orange ال بنشيل)

* $g_m V_{bc}$ ⇒ current as a function of voltage.

* hfe ib ⇒ current as a function of current.



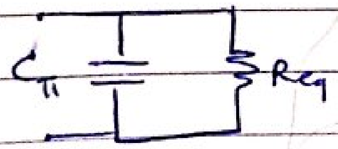
(MOSFET)



DC . Biase ⇒

$$V_c \simeq \frac{1}{2}(V_{cc} - 0.2)$$

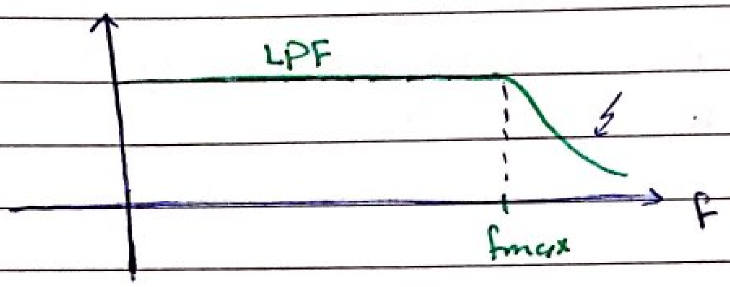
saturation voltage.



low side terminal
ground terminal.

↳ low pass circuit.

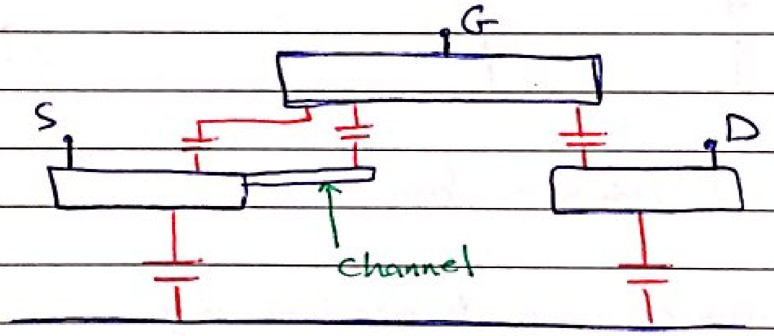
~~*~~ at low freq → low pass filter.

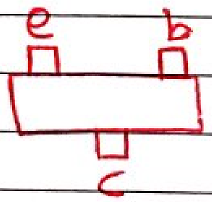


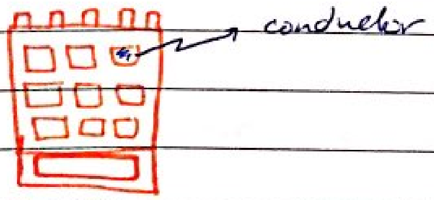
the circuit cant amplify at high frequency.

$g_m V_{be} = h_{fe} * i_b = g_m \, i_b \, r_\pi$

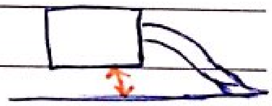
$$\boxed{h_{fe} = r_\pi \, g_m}$$







TSOK



30 mill btw 2 leg

$1 \text{mill} = \frac{1}{1000} \text{Inch}$

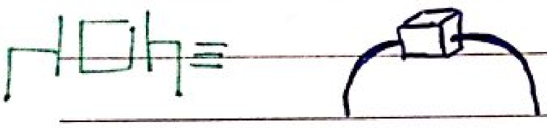
stray capacitance ↓ ← كل ما زادت المسافة

self inductance. تقل ״

Home work 2:

what are the charachtristc of galum arsinide transistor ?!

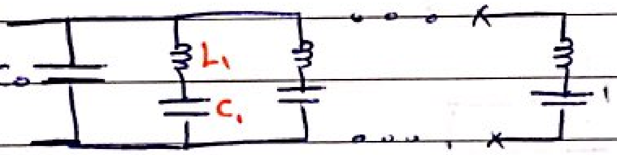
* Crystal 8Δ



(Δx, Δy, ΔZ) . angle

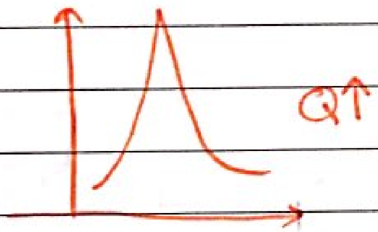
BW of component.

using as oscillator :-



input ← capacitance

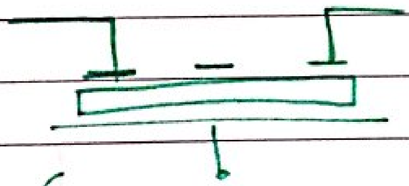
Cap C₀ بين btw 2 leg.

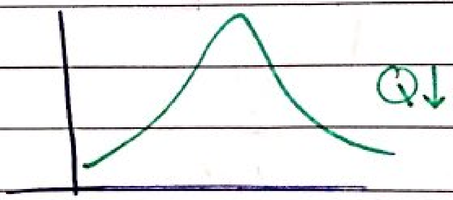


short CKt at resonance freq.

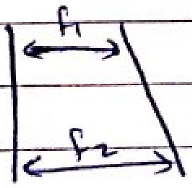
as refrence ocsillator ⇒ use at one frequency.

* Crystal Filter 8Δ





↳ as Band Pass filter. (Q↓) not sharp.

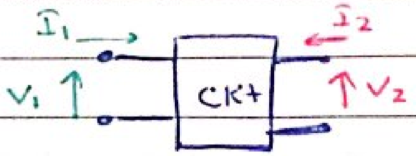


Quiz Draw equivlent high freq model. ?!

باخذ كل R, C, L ,... ← بحط model تبعهم.

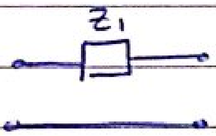
* High freq , Low freq ⇒ بنعرف الـ Cap

2-port network.

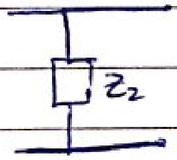


$$Z = \begin{bmatrix} A & B \\ C & D \end{bmatrix}$$

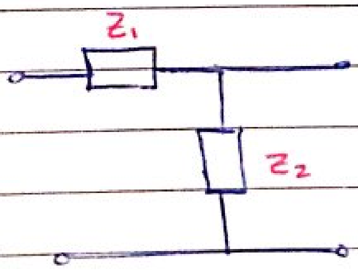
$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = Z \begin{bmatrix} V_2 \\ I_2 \end{bmatrix}$$



$$= \begin{bmatrix} 1 & Z_1 \\ 0 & 1 \end{bmatrix}$$



$$= \begin{bmatrix} 1 & 0 \\ \frac{1}{Z_2} & 1 \end{bmatrix}$$



$$\Rightarrow \begin{bmatrix} 1 & Z_1 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \frac{1}{Z_2} & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1+\frac{Z_1}{Z_2} & Z_1 \\ \frac{1}{Z_2} & 1 \end{bmatrix}$$

$$\boxed{A \cdot B \neq B \cdot A}$$

$$\boxed{\text{transfer function} = \frac{1}{A}}$$

$$V_1 = A V_2 + B I_2$$
$$I_1 = C V_2 + D I_2$$

$$\frac{V_1}{I_1} = \left(\frac{A V_2 + B I_2}{C V_2 + D I_2} \right) / I_2$$

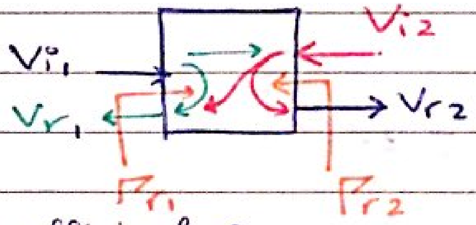
$$\frac{V_1}{I_1} = \frac{A Z_0 + B}{C Z_0 + D}$$

$\longrightarrow$ V (insident wave)

E.H

V,I

r ≡ reflect



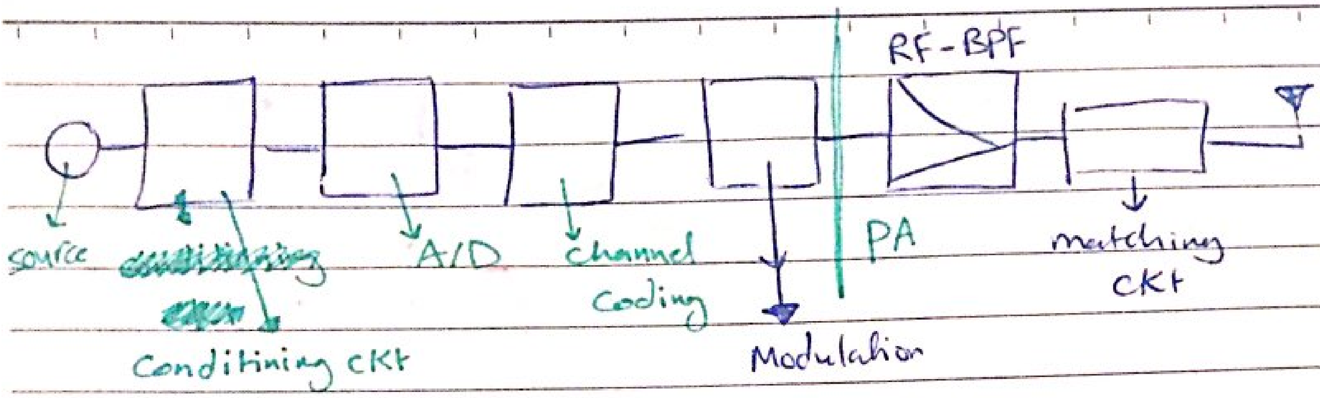
* reflection coefficient 8

$$\boxed{\Gamma_{r1}^{*} = \frac{V_{ri}}{V_{i1}}}$$

$$\boxed{\Gamma_{r2} = \frac{V_{r2}}{V_{i2}}}$$

$$\boxed{\Gamma = \frac{Z_2 - Z_1}{Z_2 + Z_1}}$$

PA = Power amplifier → (بتزيد قبل ال antena
0.5m بـ)



S Matrix 8Δ

$$S = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$$

$$\begin{bmatrix} V_{r1} \\ V_{r2} \end{bmatrix} = S \begin{bmatrix} V_{i1} \\ V_{i2} \end{bmatrix}$$

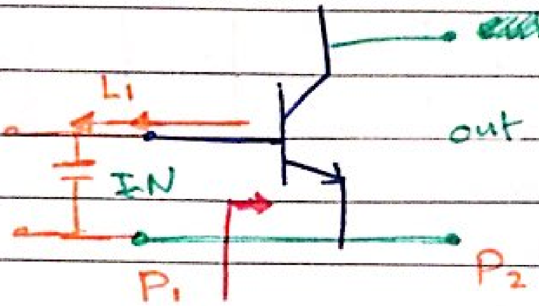
$$V_{r1} = S_{11} V_{i1} + S_{12} V_{i2}$$

$$V_{r2} = S_{21} V_{i1} + S_{22} V_{i2}$$

→ S_{22} output reflection coefficient at $V_{i1} = 0$.

Ex AT-41511 npn transistor from HP.
at 1 GHZ.

$$S = \begin{bmatrix} 0.4\angle{-144^\circ} & 0.073\angle{43^\circ} \\ 5.189\angle{89^\circ} & 0.49\angle{-39^\circ} \end{bmatrix}$$



$\Gamma = 0.4\angle{-149^\circ}$

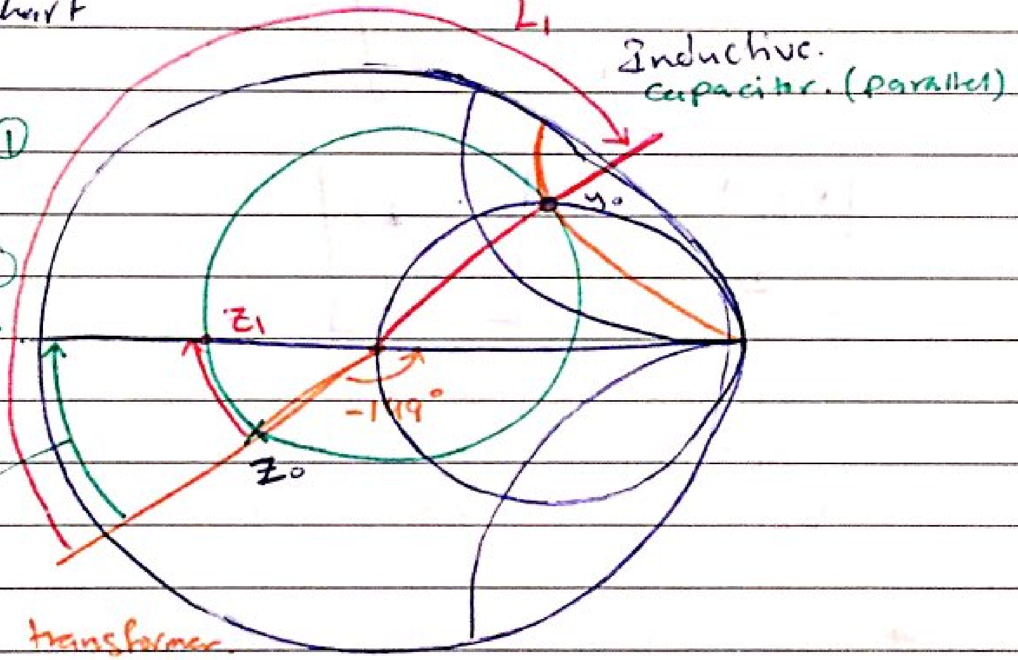
* عشان ما تضيع الاشارة عمل matching .

$\Gamma = 0.4 = ?!$

Smith Chart

① برسم النقطة ع ال Smith

② نقرأ قيم input impedence



real part. → transformer matching

* parall matching → parallel comp $<^{C}_{RL}$

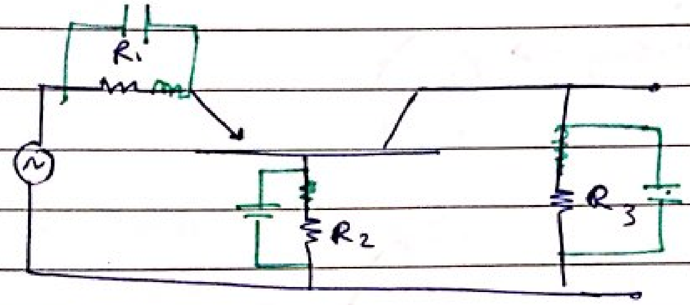
network analyzer → use to meter. the S parameter.

$Z_{Tr} = \sqrt{Z_0 Z_1}$

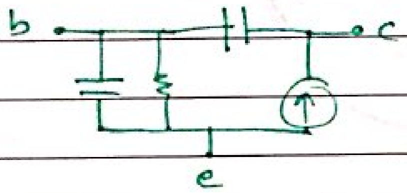
λ/4 in series ⇒
↓
Transformer

Quiz 1

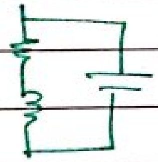
Draw the high freq model for the following CKT.



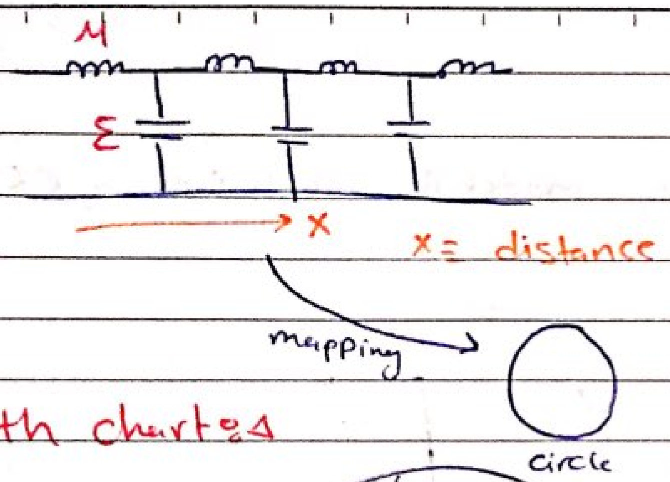
solution :-



for transistor.

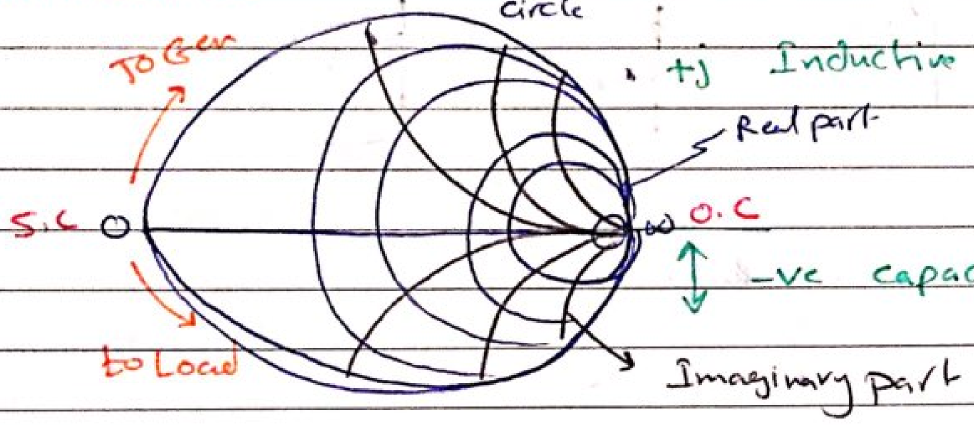


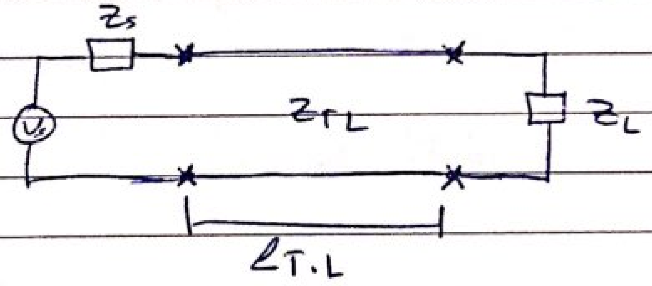
for R.



Transmission line.

* Smith charts:

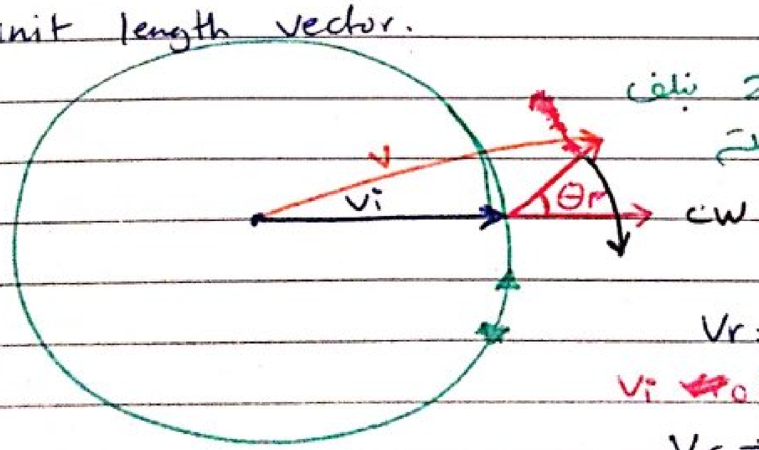




→ Vi (Vincident)

← Vr (V reflected)

as unit length vector.



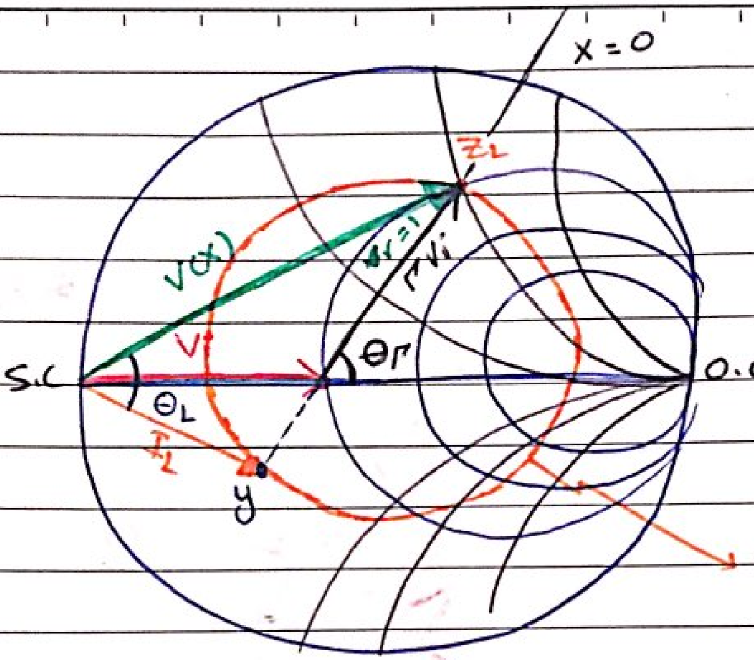
كل 2π نلف
دورة كاملة

$V_r = V_i \Gamma$

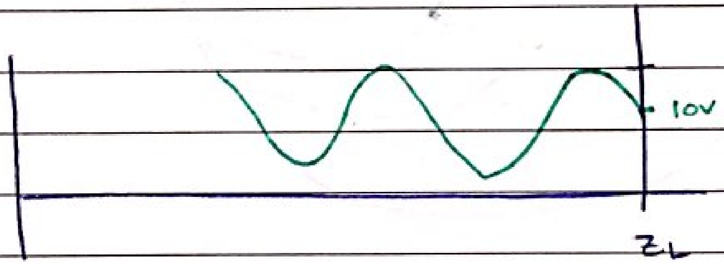
Vr متأخرة عن [illegible] Vi

$V_r \Rightarrow$ cw

$V_i \Rightarrow$ ccw



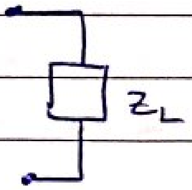
all impedoncece over Transmition Line ⇒ circle.Z_L



at center ⇒ $(1+j0)$ → (matching point).

$Z_L = a + jb$

$y = \frac{1}{Z} = \alpha - j\beta$ (in parallel)



Ex: $Z_L = 5 + j10$

$y_1 = \frac{1}{5+j10}$ =

$= 0.04 - j\,0.08$

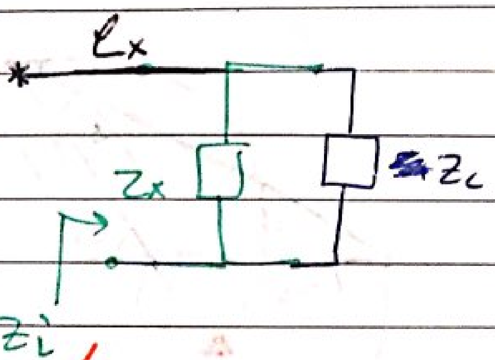
$Z_L = 4 + j10$ بدي

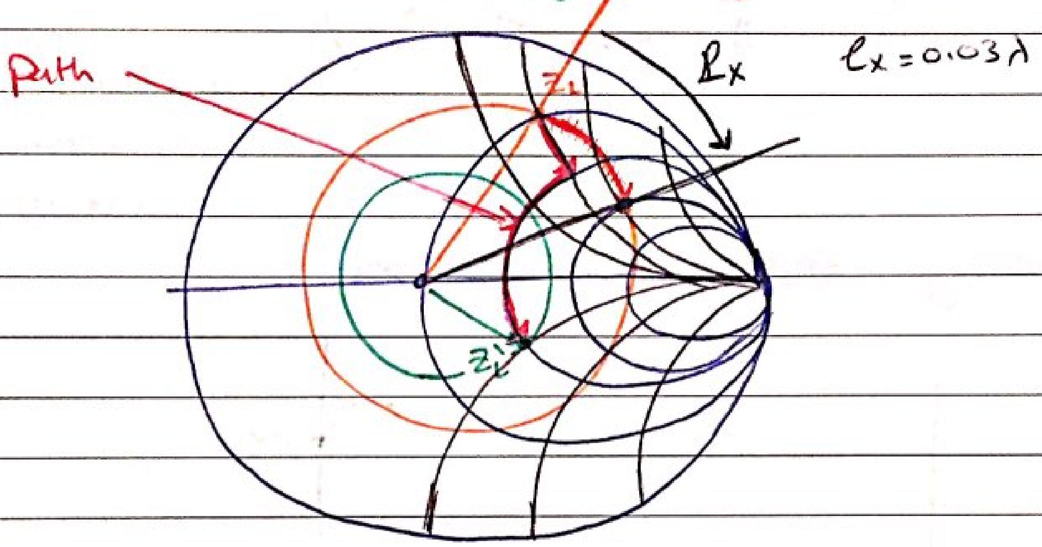
$Z_2 = 4 + j10$

$y_2 = 0.034 - j0.086$

$\Delta y = Y_2 - Y_1$

change impedence



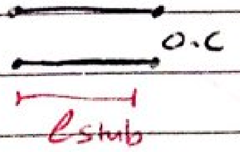


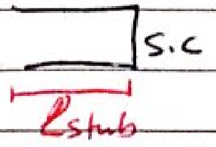
Ex : $Z_L = 0.5 + j0.1$

$Z_2 = 0.4 + j0.1$

R → R↑ → in series. add Resistor
  → R↓ → in parallel. add Resistor.

stub → theres NO R. (عبر بدارة فاضي)





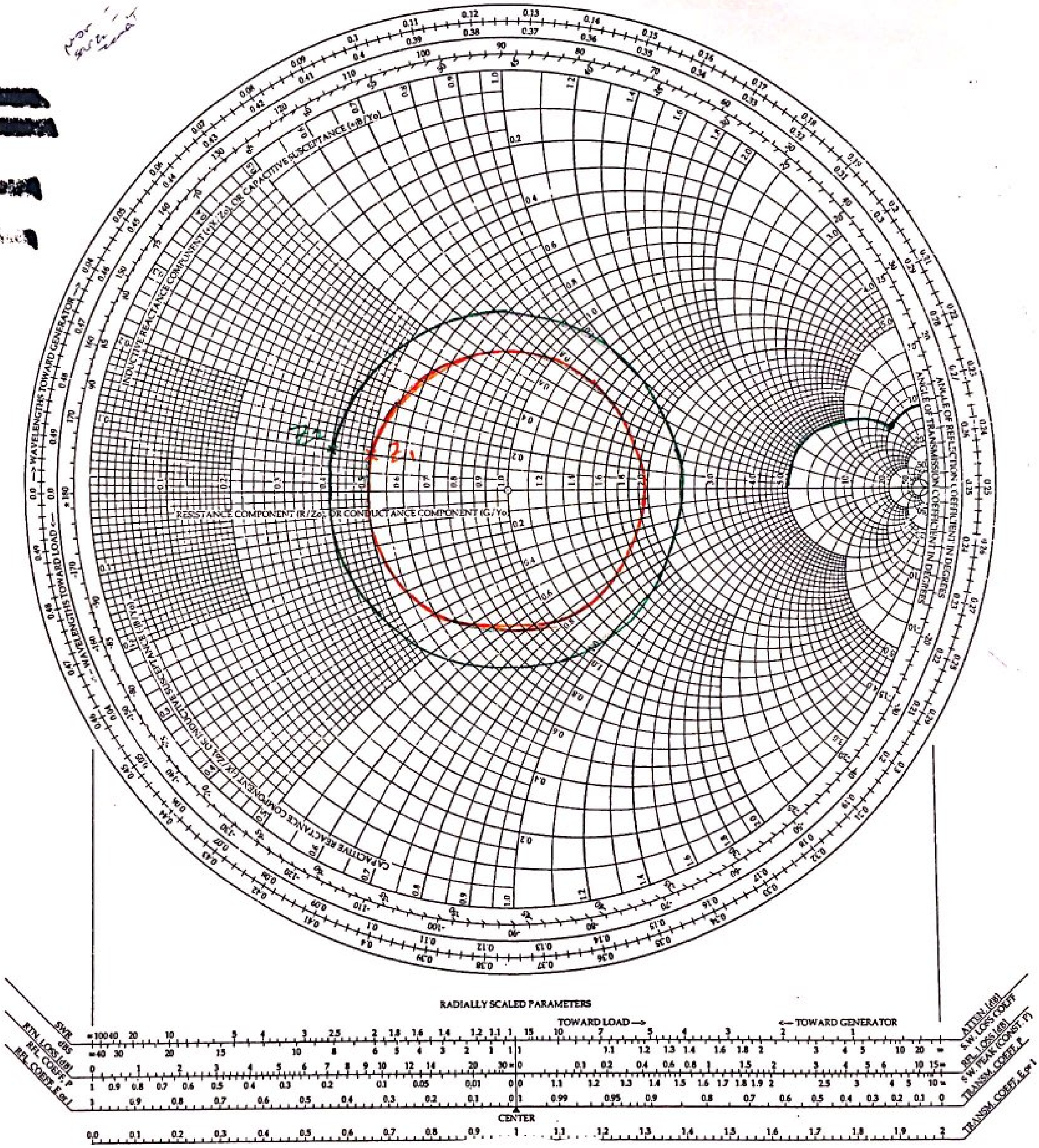
* freq ⇒ constant ⇒ λ constant.

7/3 WED

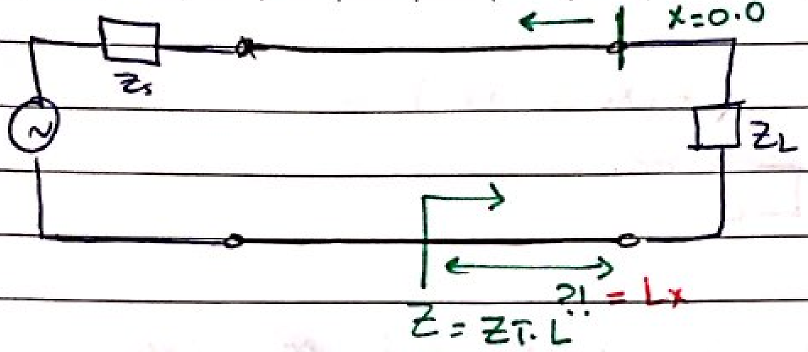
The Complete Smith Chart

Black Magic Design

[redacted]



Scanned with CamScanner



L/m C/m

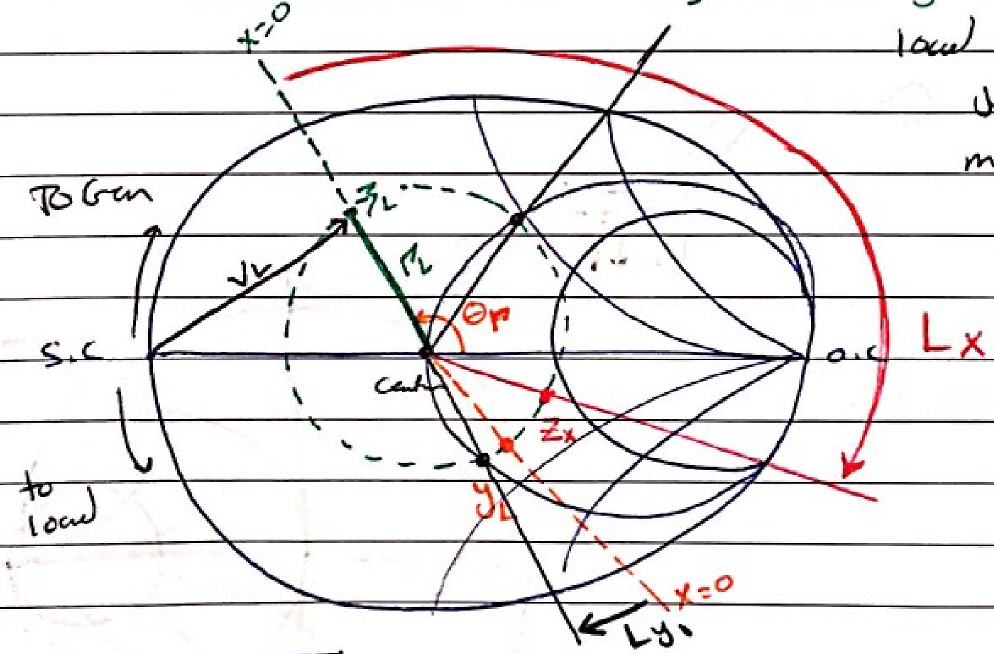
$$Z = \sqrt{\frac{L}{C}}$$

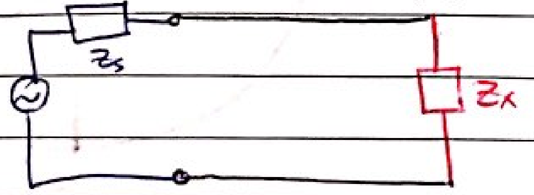
$$V(t) = A\cos(\omega t - \beta z)$$

$Z_{T.L} = 50\ \Omega$

نقطة الـ matching هي الـ center.

* بيبدأ من عند load
عشان اعمل
matching for load





① Stub matching $(+jX_s , -jX_s)$

Stub means $\overset{L}{\underset{C}{\sqsubset}}$ or

→ ~~Series~~ capacitor → DC path. ~~ax~~ فقط

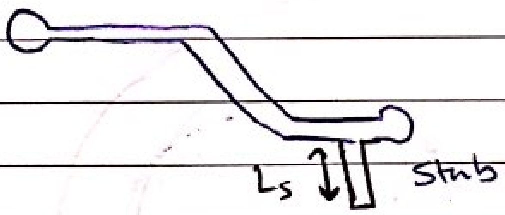
→ inductor in parallel → short ~~a path~~. s ckt path.

⇒ $y_{L_1} = 1 - jy_x$

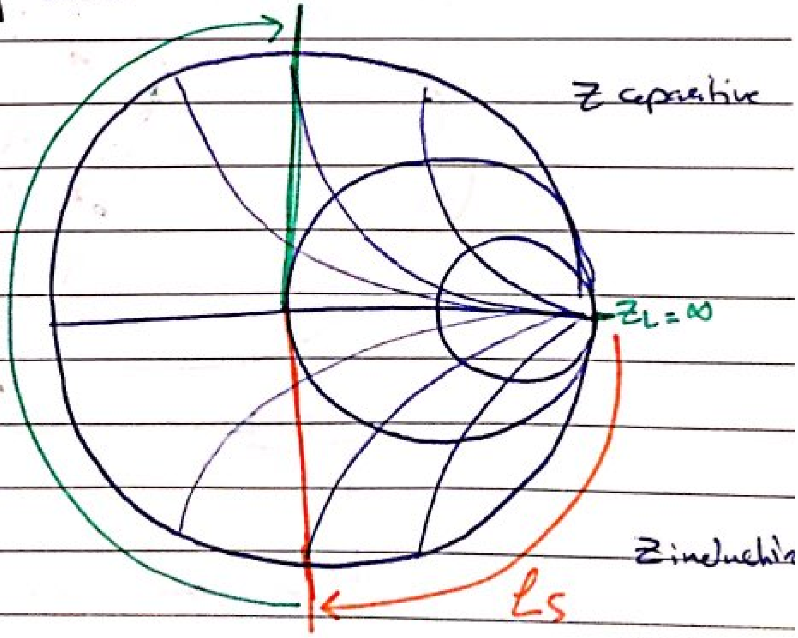
stub → $+jy_x$ → (capacitor)

capacitor in parallel → O.C DC (DC ما بأك path)

(capacitor in ~~cap~~ parallel الكل الاعضم استخدم) *



$$Z_{stub} = \frac{1}{y_{stub}}$$



$\boxed{Ex}$ $Z_L = 100 + j80.$

$\lambda = 1cm$

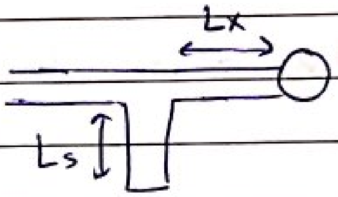
$l_x = 0.215\lambda$

$jy_x = +j1.3$ → y for load.

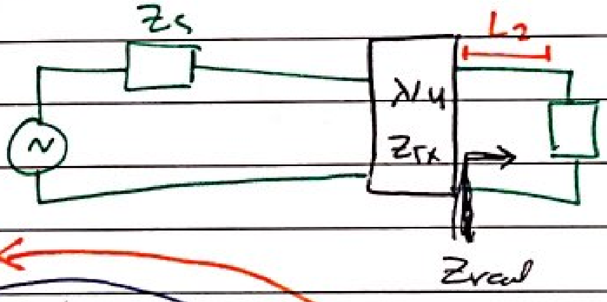
for stub → $y_s = -j1.3$ → $z_s = +j0.77$

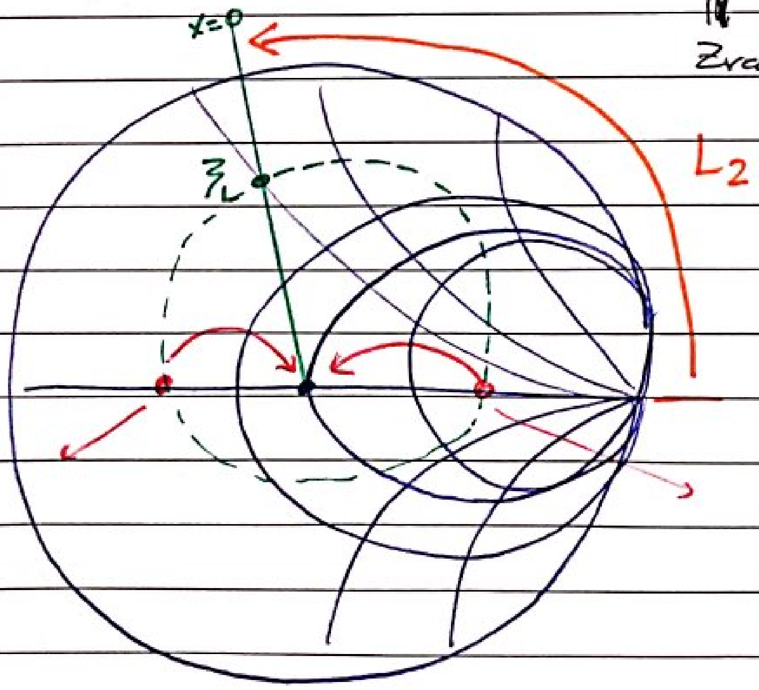
O.C stub

$l_s = 0.25\lambda + 0.105\lambda = 0.355\lambda$



* λ/4 Transformer:-

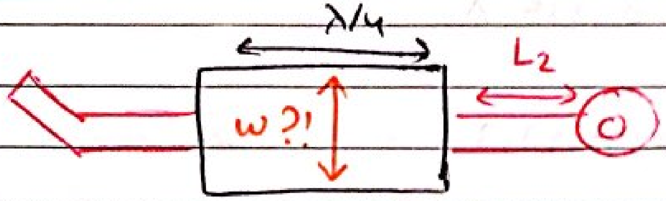




~~بكون~~ بكون ال volt
اقل ما يكون

بكون volt
اكبر ما يكون

$$\boxed{Z_{Tx} = \sqrt{Z_{rad} \times Z_{T.L}}}$$



w ≡ width

يفضل يكون اكبر من trac .

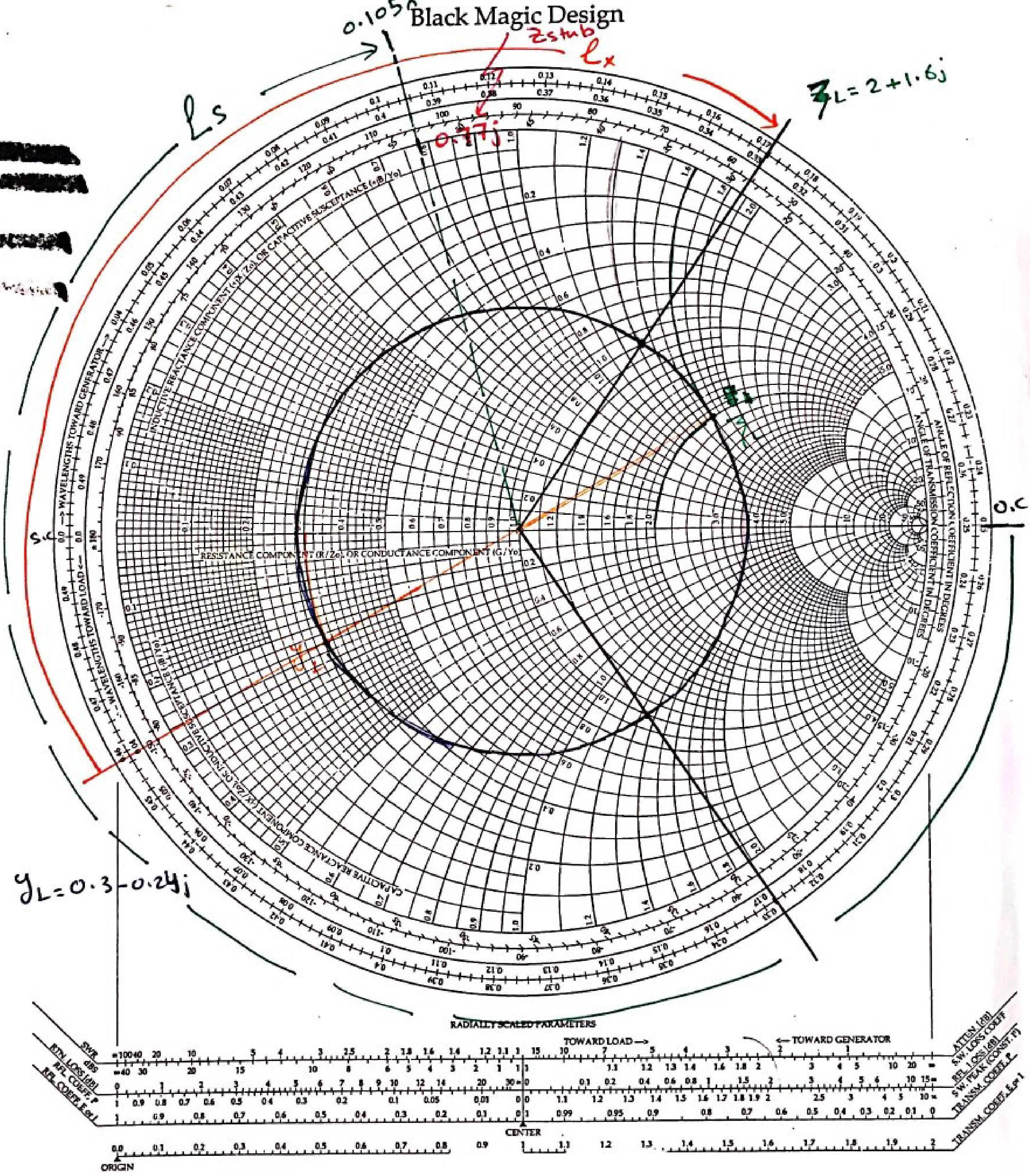
λ/4 ⇒ transform the impedance.

MON 12/3

The Complete Smith Chart

Black Magic Design

[redacted]



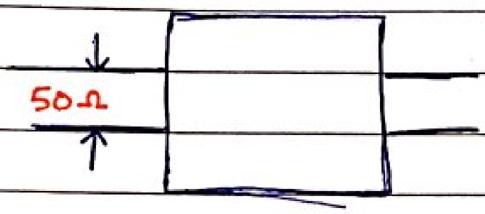
Scanned with CamScanner

14/3 WED

HFSS :-

⇒ read chapter 2 , read $\frac{\lambda}{4}$ transformer.

λ/4



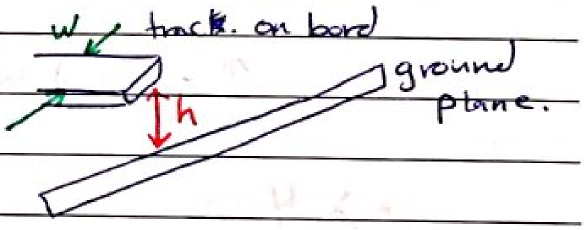
1m inside ℱc.
3m outside

For Micro-strip :-

$$Z_{o_{T.L}} = \frac{Z_0}{2\pi\sqrt{\epsilon_{eff}}} \ln\left(8\frac{h}{w} + \frac{w}{4h}\right)$$

~~Eeff~~

FR4 = εr = 4.4–4.6



$$\epsilon_{eff} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left[\sqrt{1+\frac{12h}{w}} + 0.04\left(1-\frac{W}{h}\right)^2\right]$$

* H ⇒ ثابت ⇒ H= 1.5 ع و W ← متغير

4 layer = $\frac{1.5}{4}$

$$Z_o = \sqrt{\frac{\mu_o}{\epsilon_o}} = 120\pi = 377\ \Omega$$

Find $Z_{T.L}$ using numerial method.

$H = 1.5$

$\boxed{Ex}$ $w = 5\,mm$, $H = 1.5\,mm$

$\varepsilon_r = 4.4$

$\varepsilon_{eff} = 6.563$

$Z_{T.L} = 27.48\ \Omega$

* Home work 2 → on matlab

عند تجريبي w بتعطيني $(50 = Z_{T.L})$

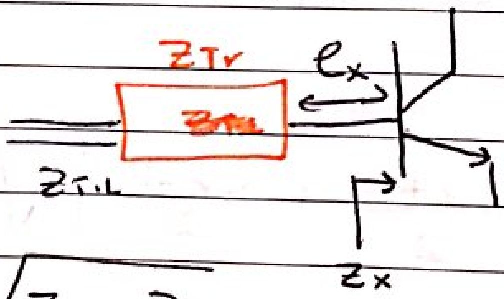
$\boxed{2}$ $w = 3\,mm$?!

$\varepsilon_{eff} = 7.2377$

$Z_{T.L} = 35.227\,\Omega$

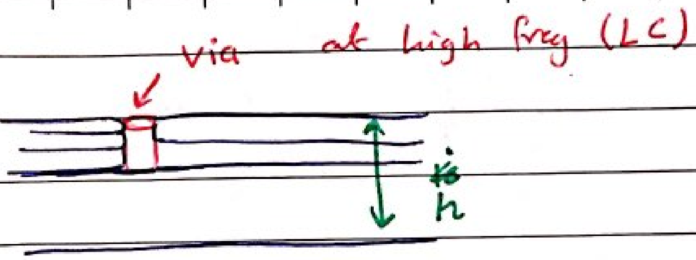
$\uparrow Z \rightarrow \downarrow W$

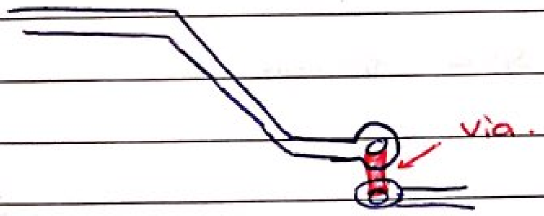
* $\lambda/4 \Rightarrow$

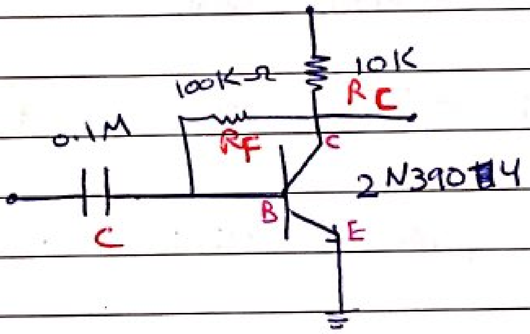


$Z_{Tr} = \sqrt{Z_x \cdot Z_{TL}}$

19/3 MON

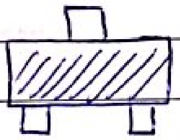


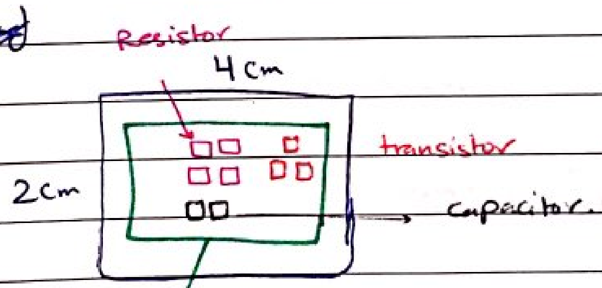


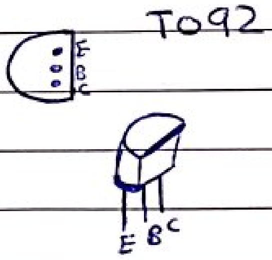


printed ckt Board. :

~~Board~~



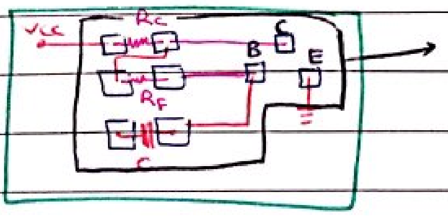




4 layers.

Keep in region منطقة الي بدي اوزع فيها

Routing ⇒

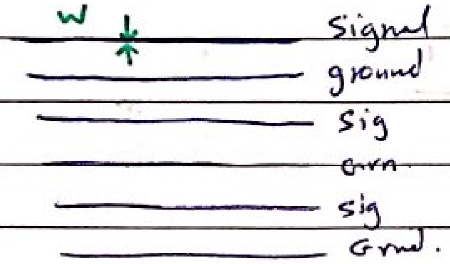


ضيف معدن (قالب)
at high freq

* area : ground plan , track مسافة بين

"وين حاطي track في ground plane كو".

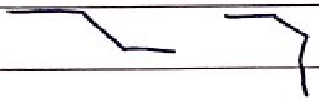
center to center = 2w



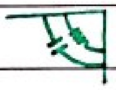
↑ wire → ↑ speed through it

rule ① 2W

② No sharp edge.

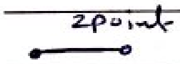


90° → ↑ inductance.



* track path → horizintal or vertical best path.

delay TL → $\sqrt{LC}$



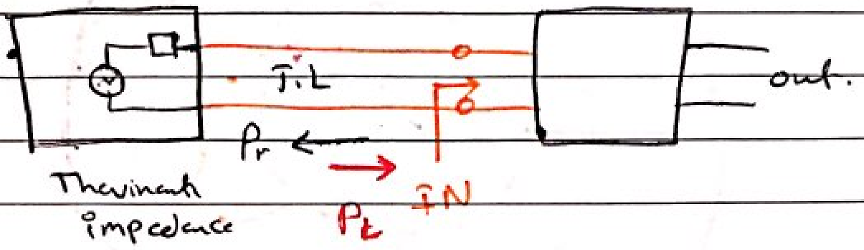
speed ⇒ $\frac{1}{\sqrt{LC}}$ = u meter per sec.

per meter
per meter.

26/3 MON

* Mid in 4/4 Wed

2 Port Network :-



for wide band → must do sweep.

narrow band. ⇒ cos (wot)

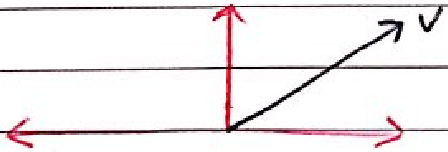
$$* \ \frac{\Delta f}{f_0} = \begin{cases} \ll 1 \longrightarrow \text{narrow band} \\ \sim 1 \longrightarrow \text{wide band} \end{cases}$$

* narrow band → only fo

* wide band → must sweep. analysis.

Pr ⇒ nulling (fading.

لما تتعاكس ال signal درجة عن نفسها (180°)

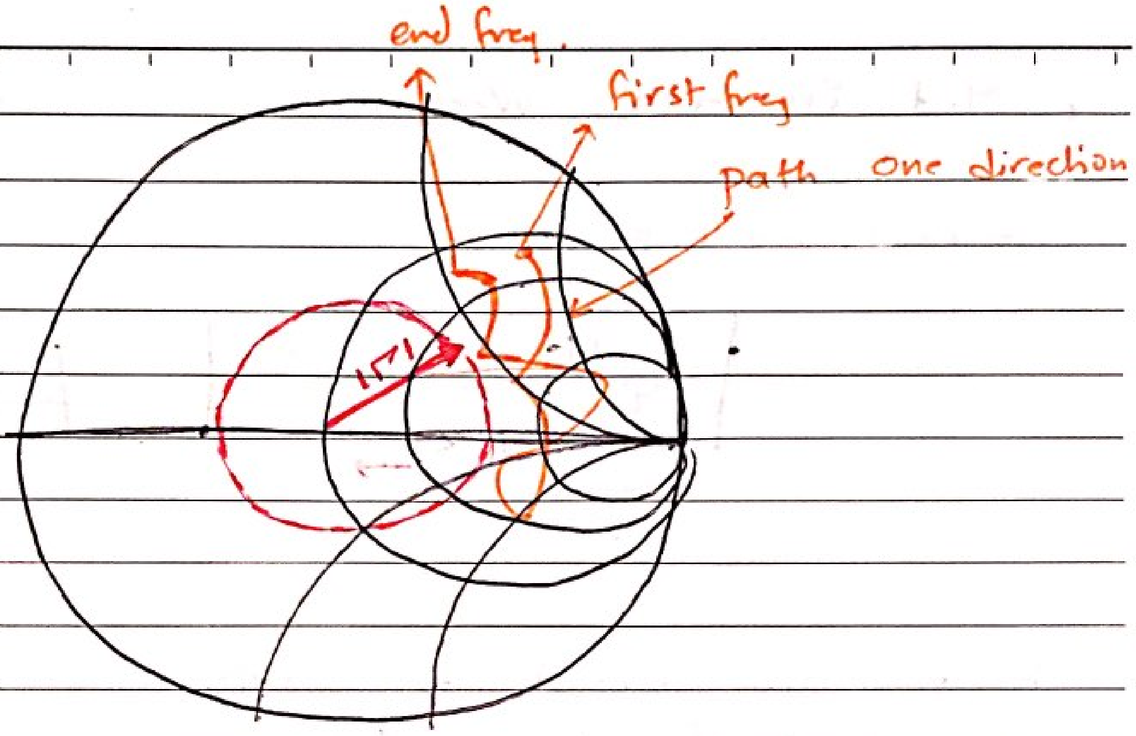


S-parameter :-

S_{11} → reflection coefficient.

39

Smith Chart:-



⇒ $P_t = \frac{Vin^2}{Z_{i.L}}$ ⇒ transmitted

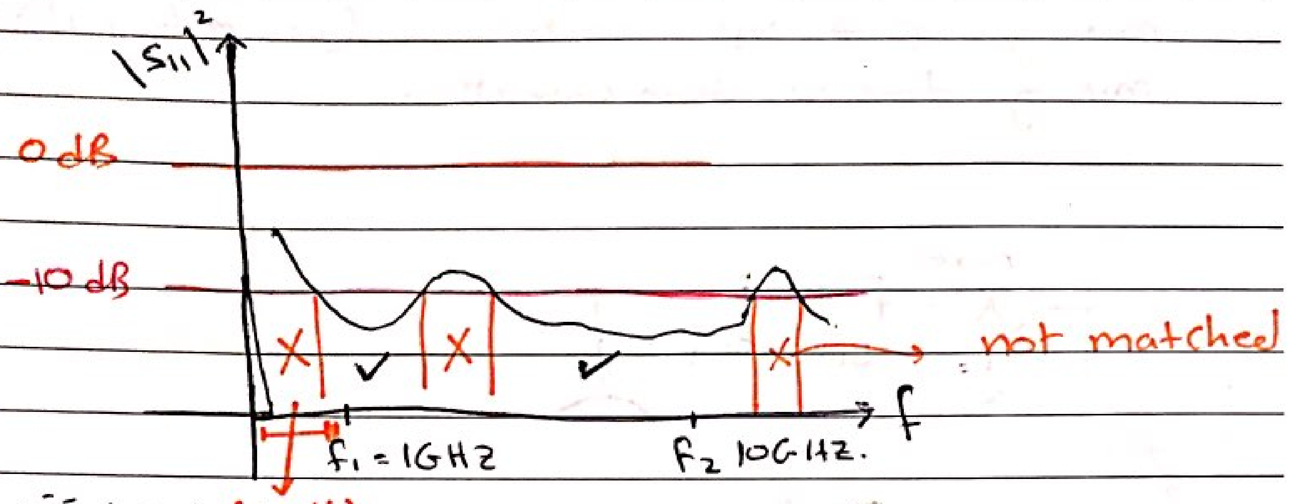
⇒ $P_r = \frac{|\Gamma \, Vin|^2}{Z_{i.L}}$ ⇒ reflected.

$$\boxed{P_r = |\Gamma|^2 \cdot P_t}$$

Power loss % = $\frac{P_r}{P_t} = |\Gamma|^2$ unitless

in dB

$$\boxed{\downarrow \underset{Return}{Loss} = 20 \, Log \, (S_{11})}$$



(null) مابدي استقبل بهاد range

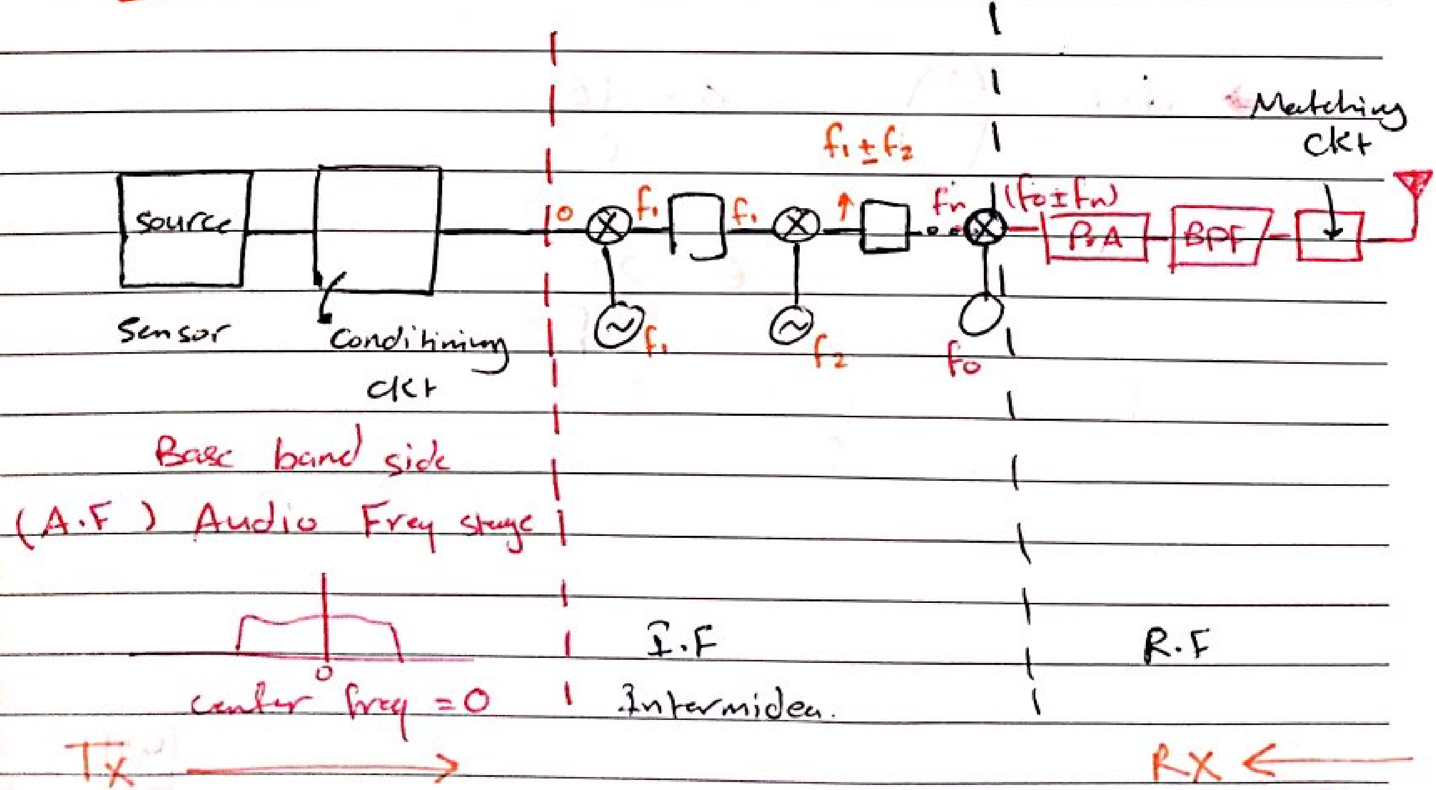
$\boxed{S_{11} = 1 \rightarrow 0 dB}$

عما تكون قيم ال S11 قليلة بحل matched.

* Solution in narrow band ➡ add stub or douple stub.

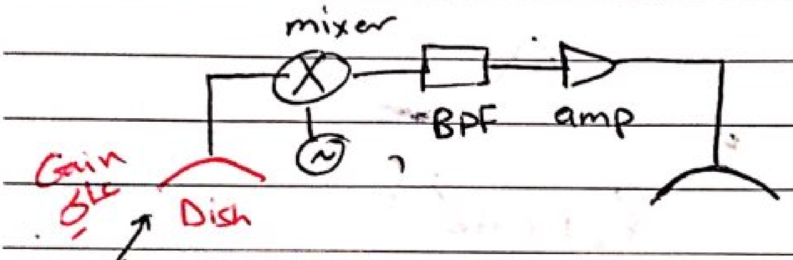
radiation pattern ⇒ space كيف بيبث الطاقة باتجاه ال

$\boxed{\text{return loss} < -10 \text{ dB}}$ ⇒ for design



mixing up → up converter. (Low → high), (Tx → Rx)

mixing down → down converter.



down converter.

T.P

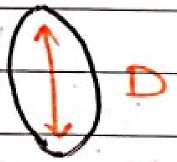
عالي freq (تخلي الـ loss [illegible] عشان)

free space loss

$\cancel{\lambda f // \frac{\lambda^2}{4\pi r^2}}$

$$\boxed{L = \frac{\lambda^2}{4\pi r^2}}$$

$$L = \frac{c^2}{4\pi f^2 r^2} \Rightarrow f\uparrow \rightarrow L\uparrow$$

➡ dish 

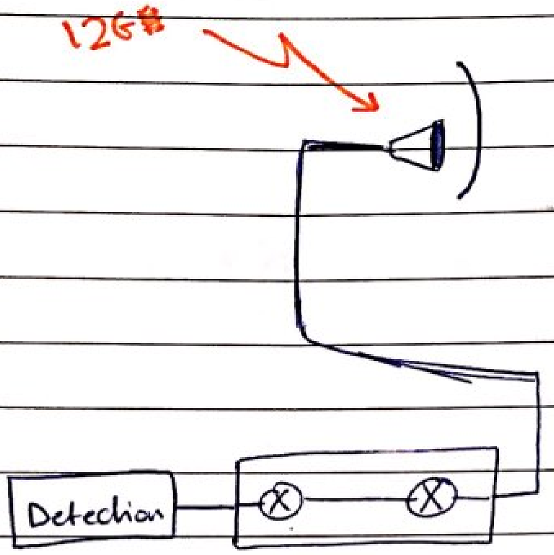
$$G = \frac{16}{\theta^2}$$

$$\theta = \frac{22}{D \cdot f}$$

$D = 5\lambda$ best than $D = 4\lambda$

↳ gain ↑

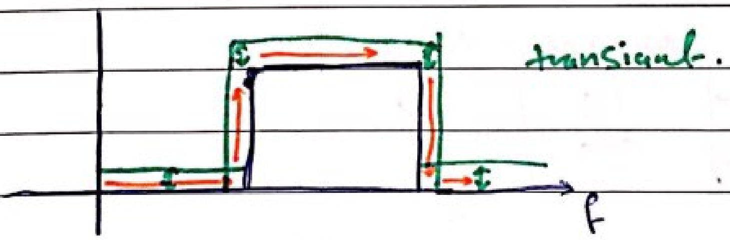
28/3 WED

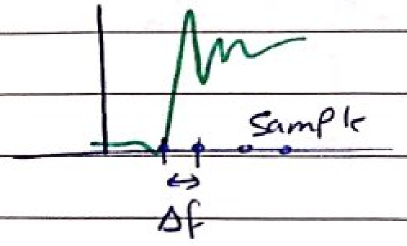


$$\Rightarrow \text{output filter} = \sum_{j=0}^{J+1} w_j \, x(t-\underset{\substack{\downarrow \\ \text{delays}}}{\tau_i})$$

w = weight

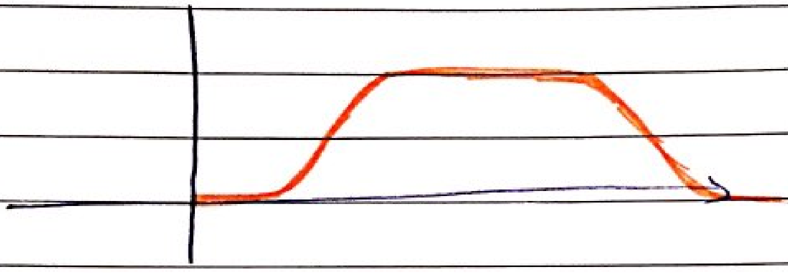
$$\text{OR} \quad \text{out} = \frac{1}{\sum_{j=0}^{J=1} \alpha_j \, x(t-\tau_i)}$$





* Back to analog
→ ripple.

$$\Delta f = \frac{f_s}{N} \rightarrow \text{frequency resolution.}$$



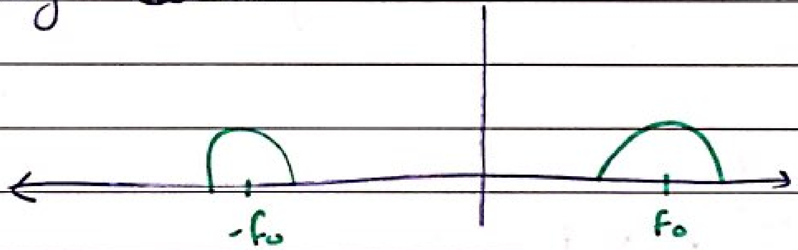
Modulations:

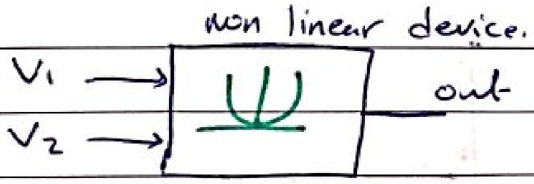
$Z = V_1(t) \cdot V_2(t).$

$V_2(t) = 2\cos(w_0 t)$

$Z = 2V_1(t)\cos(w_0 t)$

frequency domain.





$$out = \sum_{i=0}^{N} \alpha_i V_{in}^{i}$$

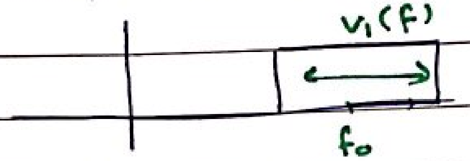
N ≡ order of the polonomial.

if N=2 ⇒

$out = \alpha_0 + \alpha_1(V_1+V_2) + \alpha_2(V_1+V_2)^2$

$$out = \alpha_0 + \alpha_1 V_1 + \alpha_1 V_2 + \overbrace{\alpha_2 V_1^2}^{\text{base band}} + \alpha_2 V_2^2 + \underbrace{2\alpha_2 V_1 V_2}_{\text{modulation}}$$

⇒ BPF at f_0.



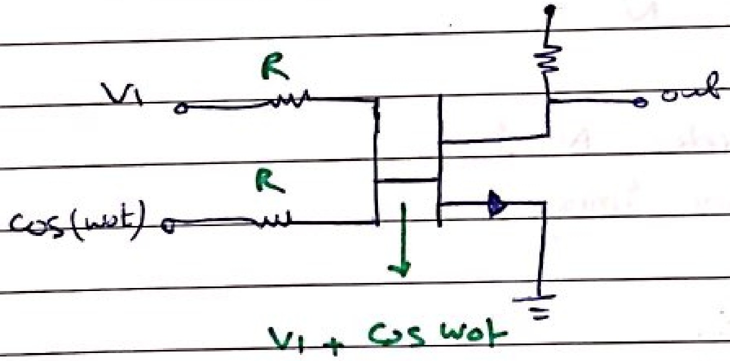
$V_1(f) < f$ *

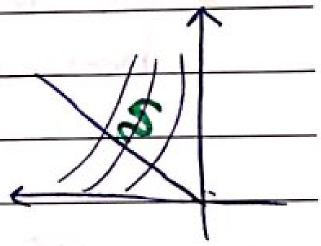
$$\Rightarrow 2\alpha_2 V_1 \cos(w_0 t) + \alpha_1 \cos(w_0 t).$$

if $\alpha_1 \simeq 0$

$out = 2\alpha_2 V_1 \cos(w_0 t)$.

FET Transistor relation btw input, output square.





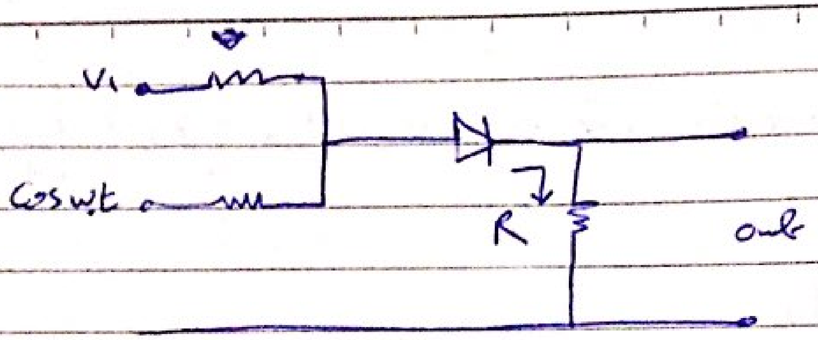
$out = K V_{in}^2$

if $N = 3$ ⇒

$out = \alpha_0 + \alpha_1 V_1 + \alpha_1 V_2 + \alpha_2 V_1^2 + \alpha_2 V_2^2 + 2\alpha_2 V_1 V_2$

$+ \alpha_3 (V_1 + V_2)^3$

$\Downarrow \quad V_1^2 V_2 \Rightarrow V_1^2 \cos w_0 t.$



Diode relation exponential.

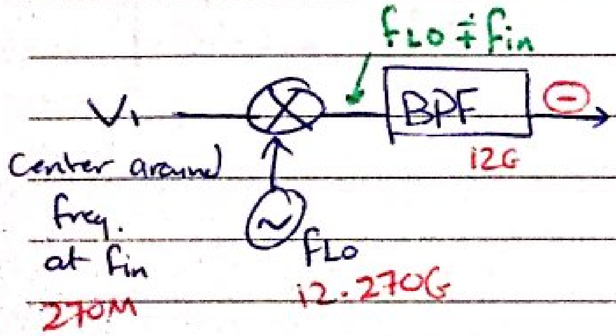
order N

image freq ≡ f_I

$$\boxed{f_I = \frac{f_o}{n} \mp m\frac{f_{IF}}{n}}$$

n, m = 1,2, ... N.

⇒ Idel mixer order N=1
best case one image.



12G ⇒ $f_{LO} - f_{in}$

* Filters:

⇒ types:

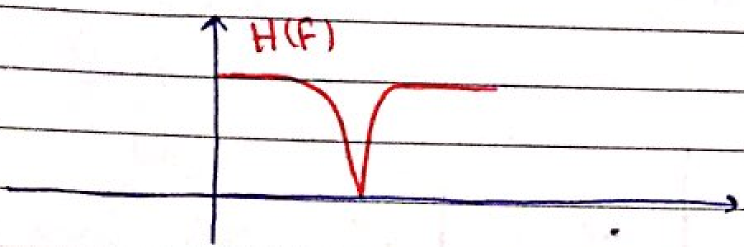
1 LPF
2 HPF
3 BPF
4 Notch Filter
5 Band reject filter
6 General filter.

2/4 MON

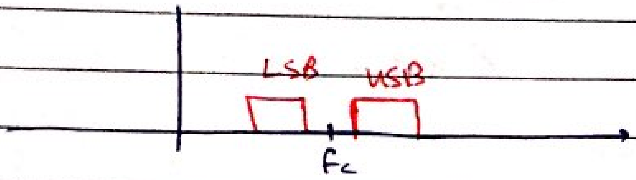
λ↑ → Shrink :

Filter:-

* Notch Filter → بتقل ال Signal في notch معين



in freq domain.

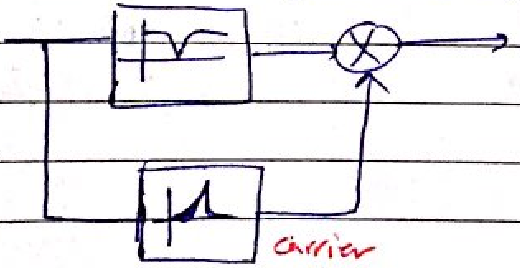


Pilot carrier.

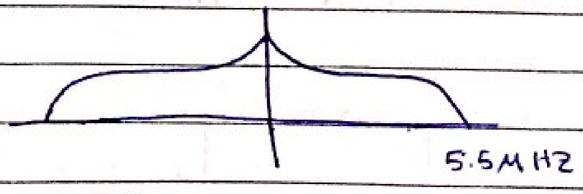
USB = upper side Band.
LSB = lower " "

use in sinkranization Signal.

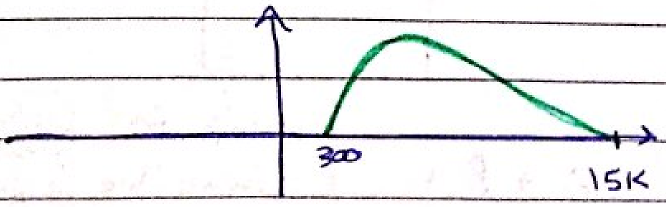
: Audio signal ما فيها DC , ما بترتبط ل video signal.



video signal
DC فيها



Audio Signal

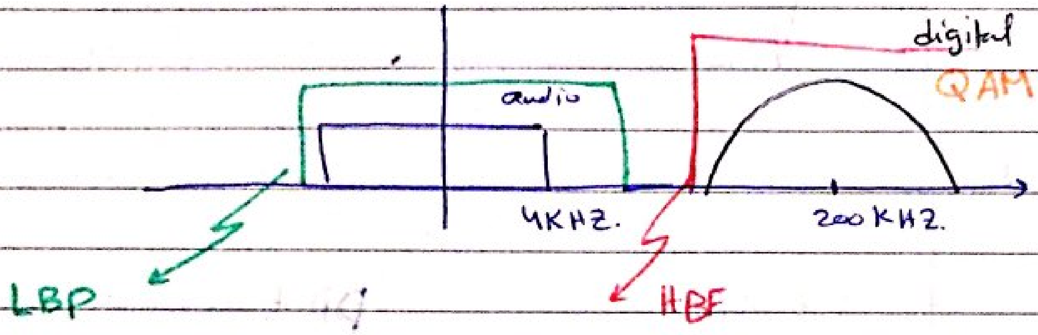


HW3:

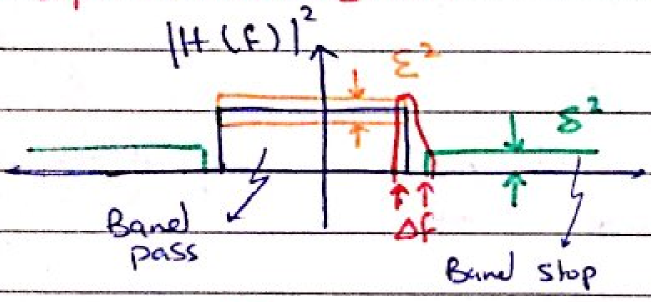
DC restoration ckt.

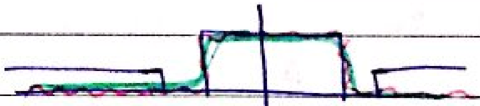
↳ يعني peak detector.

signal ← مررناها ب block cap. ← مرجعتله ال DC ، DC restoration ~~[illegible]~~ بنسميها.



* Specifications 8Δ



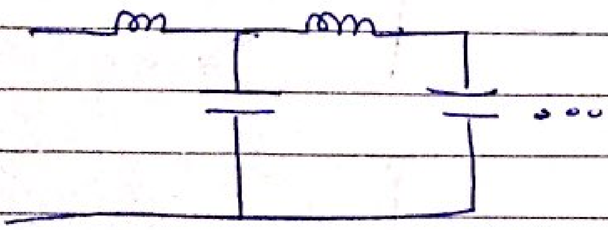


اي signal مرت filter مقبول نسبي.

~~[illegible] Function~~

$$H(f) = \frac{f^2 - 3}{5 + 2f - 4f^4}$$

not ideal → distortion (10% مقبول)

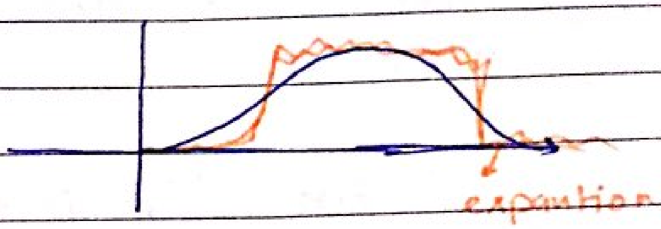


$\left(\alpha f + \frac{\beta}{f}\right)$ → low freq → قيمتو كبيرة

→ high freq → قيمتو صغيرة

$$H(f) = \frac{1}{\left(\alpha f + \frac{B}{f}\right)}$$

Band pass Filter.

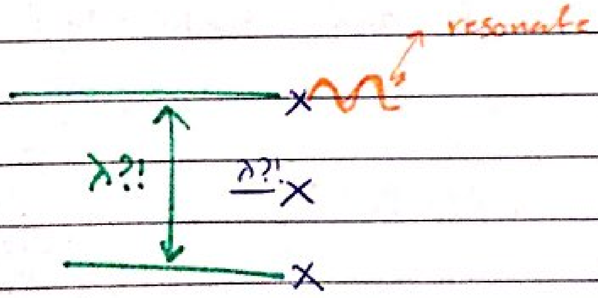


Transformation from Low pass ⟶ Band pass.

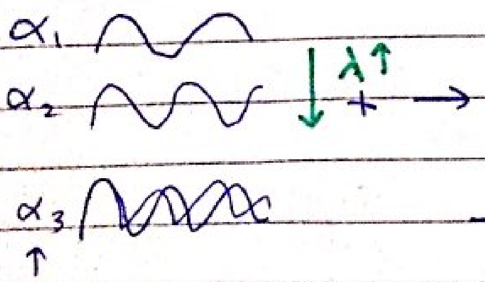
$$H(f) = \frac{1}{\left(\underbrace{(\alpha f)^n}_{L} + \underbrace{\left(\frac{B}{f}\right)^m}_{C}\right)}$$

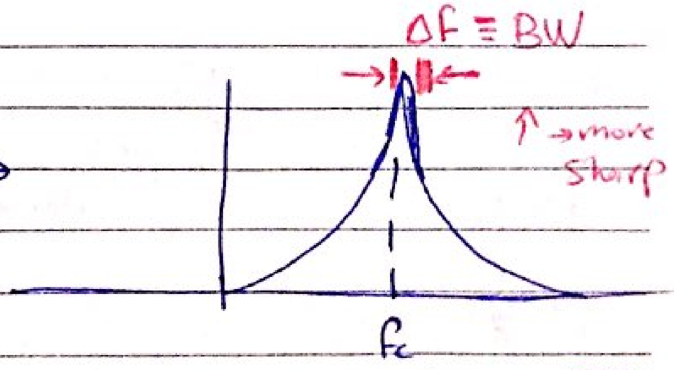
inverse ⟶ Band stop.

L,C → harmonic



إلي بدنا نعمل resonant at amplitude أقل
نخفض



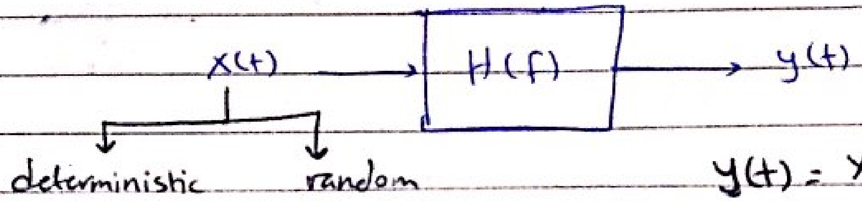


"eg crystal stable at freq معين"

9/4 MON

Filters:

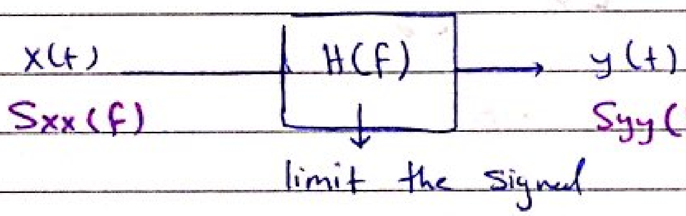
any filter can be determined as:
$H(f) = ?!$



$y(t) = x(t) * h(t)$

Histogram :- avg of the signal after apply F.T

for random x(t):



$S_{yy}(f) = S_{xx}(f) \cdot |H(f)|^2$

* we need H(f) causal and stable to represent the signal

$$H(f) = \sum_{n=0}^{N-1} \frac{A_n}{a_n + jb_n} \quad (\text{RC filter})$$

* Another representation for H(f):

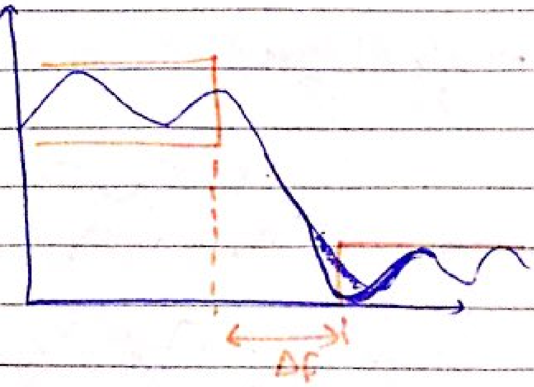
FIR :-

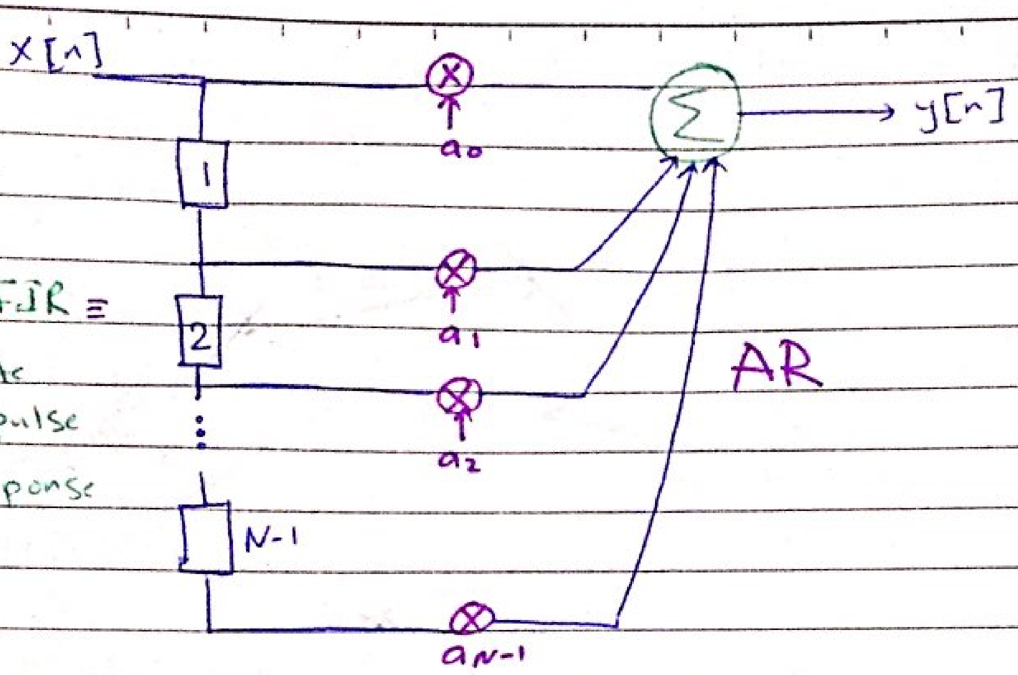
$$H_1(z) = \sum_{n=0}^{N_1-1} a_n z^{-n}$$

↳ delay in time domain

IIR :-

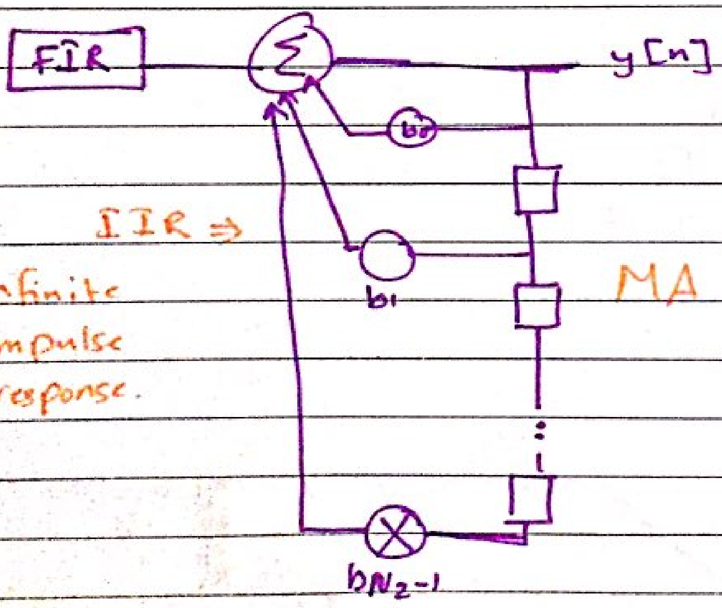
$$H_2(z) = \sum_{n=0}^{N_2-1} \frac{1}{1 + b_n z^{-n}}$$





FIR = Finite impulse response

Arma model :
$H_1(Z)$, $H_2(Z)$



IIR ⇒ Infinite impulse response.

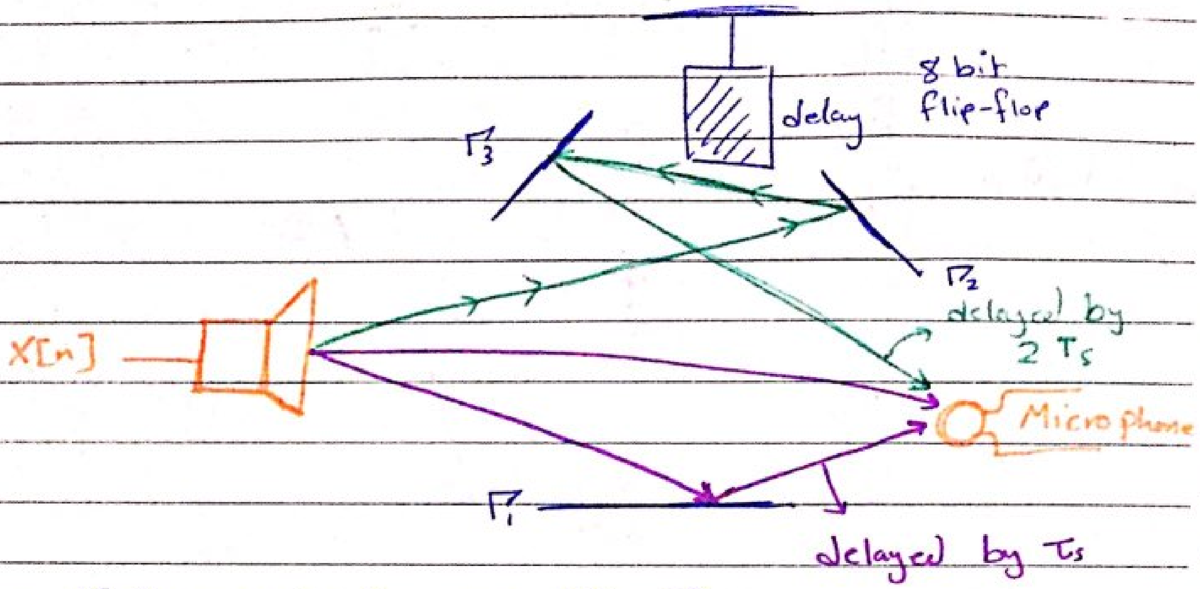
⇒ AR(10) used for Voise Signal [$N_1 = 10$]

⇒ To determine N :

[1] determine the order of the Signal

[2] how much we fit the actual Shape.

X[n] must be sampled and quantized to say that X[n] digital if X[n] is only sampled then its discrete



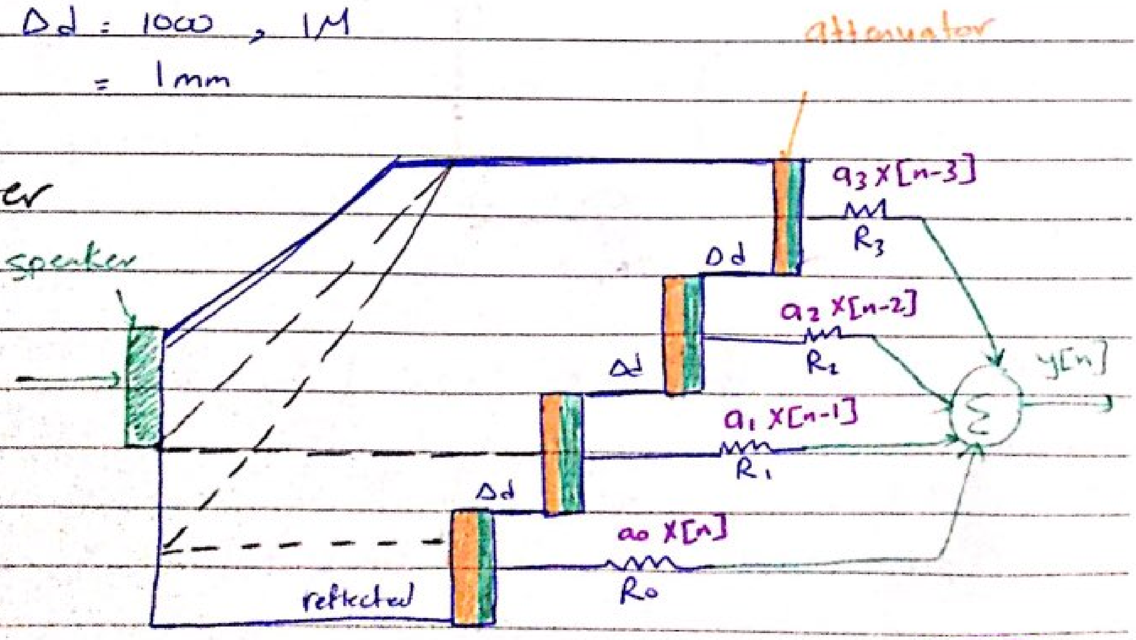
$out = X[n] + a_1 X[n-1] + a_2 X[n-2]$

$a_1 = \Gamma_1$, $a_2 = \Gamma_2 \cdot \Gamma_3$

assume $T_s = 1\mu s$
$\Delta d = \mu_s \cdot T_s$
$\mu_s = 20.3\sqrt{T}$

$\boxed{Ex} \Rightarrow \Delta d = 1000 , 1\mu$
$= 1mm$

SAW Filter

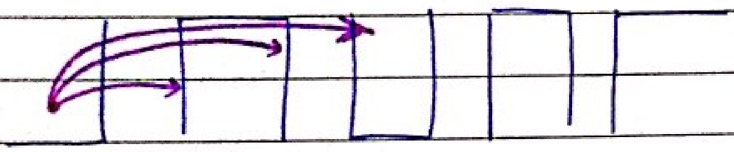


designed as a echo canceller

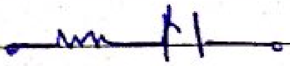
let $h[n] = a\,x[n] + b\,x[n-1] + c\,x[n-2] + \cdots$

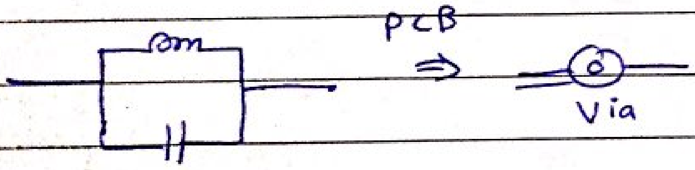
then $h(z) = a z^{0} + b z^{-1} + c z^{-2} + \cdots$

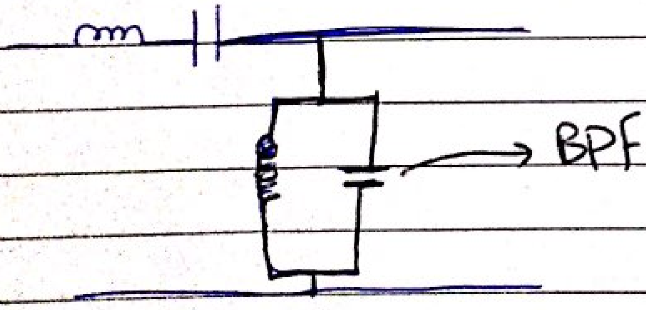
Delayed EM wave



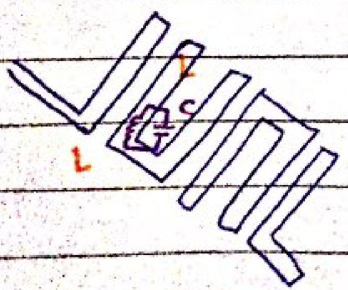
$$\sum_{i=0}^{I-1} \alpha_i\, x(t-\tau_i)$$







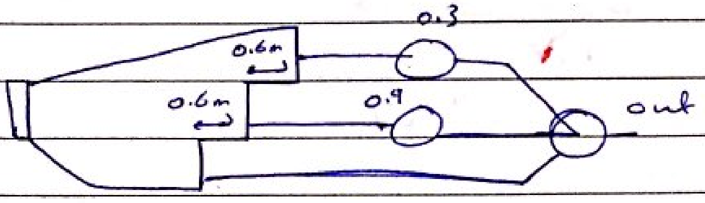
we need delay and sum

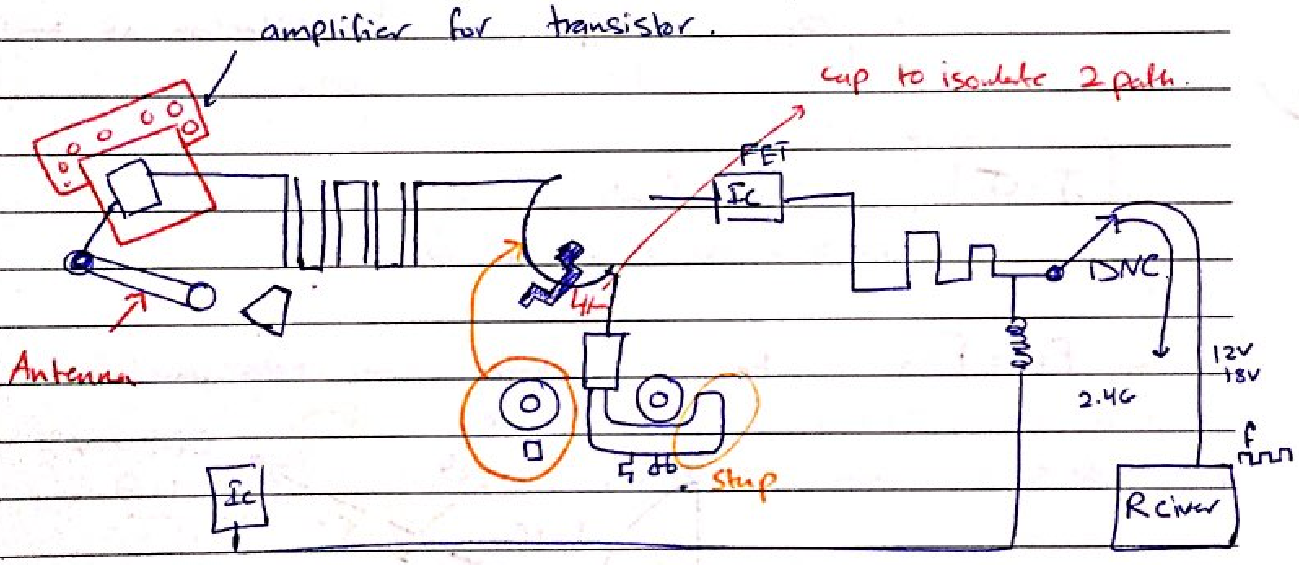


11/4 WED

Quiz 28

Design a SAW filter with $H[z] = 1+0.9z^{-1}+0.3z^{-2}$ if speed of sound is 600m/s.





stup → oscillator ic

→ stubs → RF ic

Transistor.

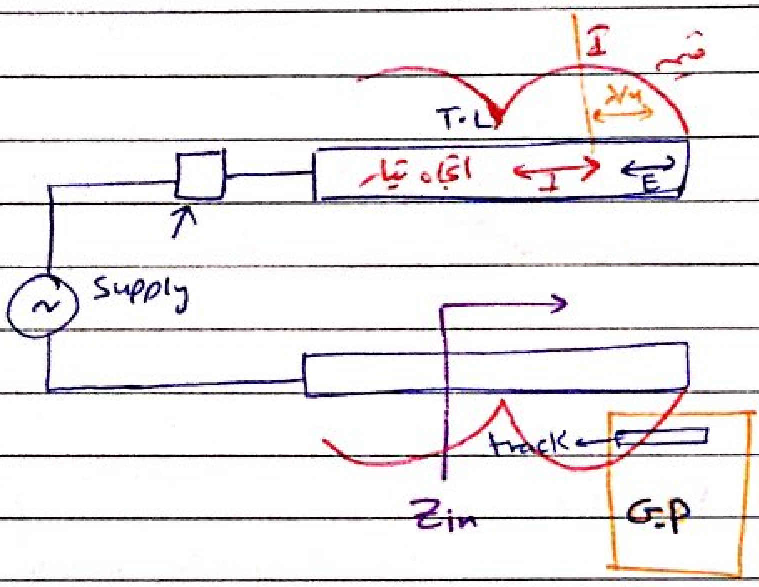
$\lambda f = u$

$u = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$

$\boxed{54}$

$\lambda_{11G} = 21.4mm \rightarrow \lambda/4 \rightarrow 5.35mm$

$\lambda_{12G} = 25mm \rightarrow \lambda/4 \rightarrow 6.25 mm.$



standing wave.

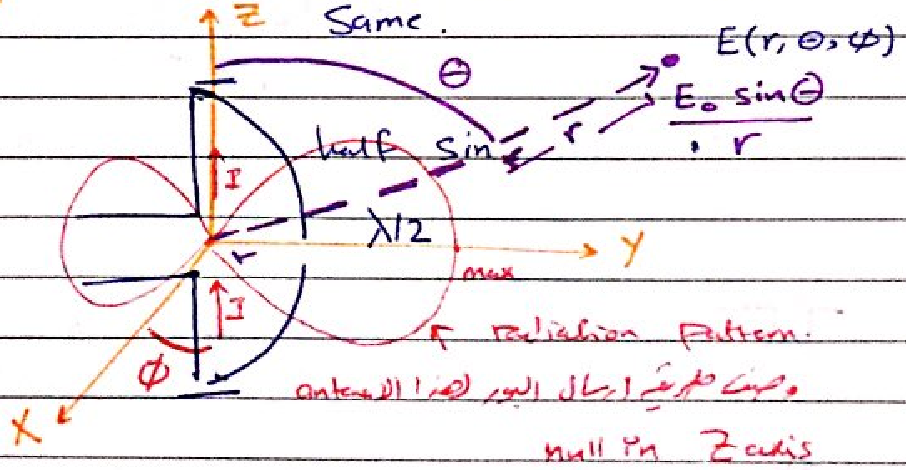
GP = Ground Plane
↳ reflection of track.

⇒ $\boxed{J = \sigma E}$ Ohm's law.

اتجاه تيار و E بنفس الاتجاه.

⇒ $\boxed{E_{t_1} = E_{t_2}}$ because voltage across two parall the Same.

* Dipole :



بيبين طريقة ارسال الموج لهذا ال antena

null in Z axis

current half Sine → E sin

* sin θ = radiation patteren

Power Density = Pr(r, θ, φ)

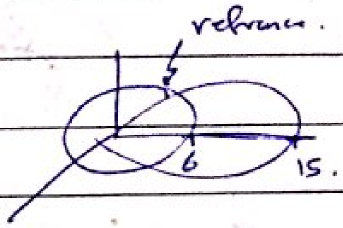
⇒ $\boxed{Pr(r,\theta,\phi) = P_0 \frac{\sin^2(\theta)}{r^2}}$

$\boxed{P_0 = E_0^2}$

gain ⇒ max radiation.

↳ [illegible]

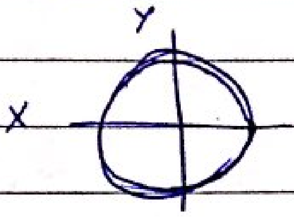
if antenna → radiation circul

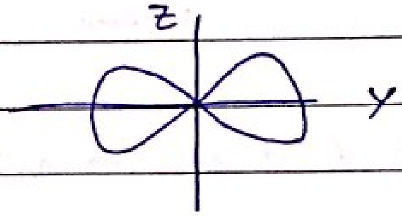


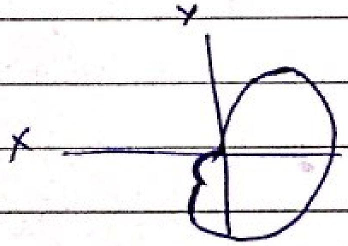
$$gain = \frac{15}{6}$$

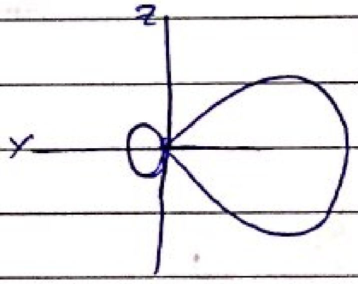
Horizintal.

vertical radiation pattern.

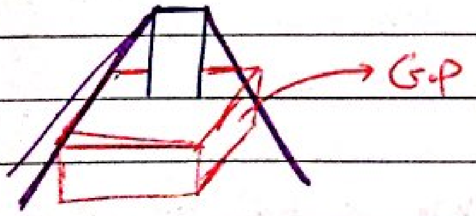








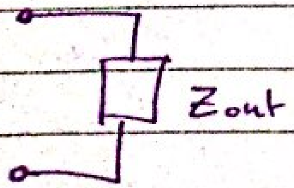
mono pole.



كبرنا GP ← بتكبر الظل .

مظل بشوفو ← برا الظل ما بشوفو

input impedance → o.c → ∞ = Z

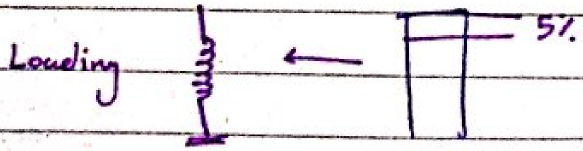


$dipole = 53 - j72$. $= R_{rad} - X_{stored}$

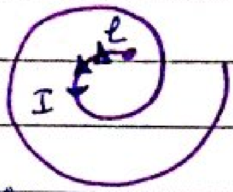
↳ stored Energy

↳ radiated resistor

(Loading antenna) 5% antenna بدي اتخلص منها بقص ال



Spieral



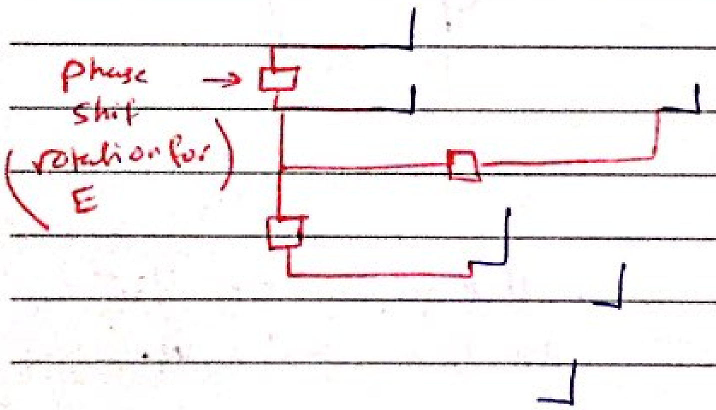
$$E = \sum_{i=0}^{\infty} \overrightarrow{E_i} = \int_{l} E_i \, dl.$$

length of antenn. ← l

..

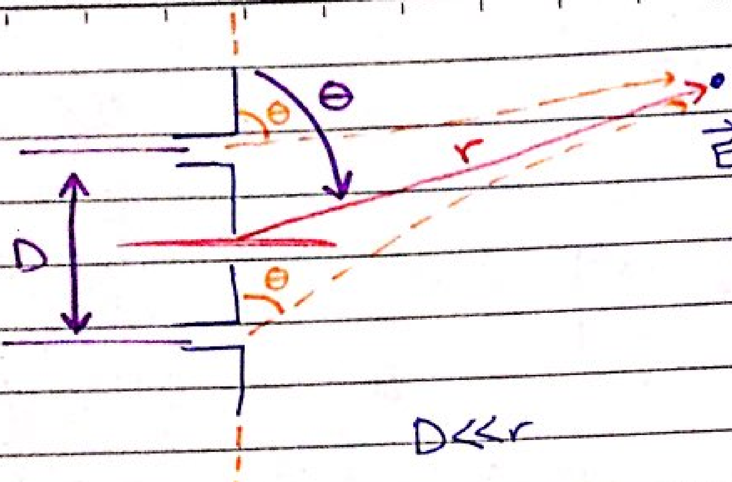
⇒ typical size → λ/2 , λ/4

* array 84 عدد ال antenn.



you ↑can. control radiation pattern by control the phase shift.

16/4 MON



$\vec{E} = \vec{E}_1 + \vec{E}_2$

$D \ll r$

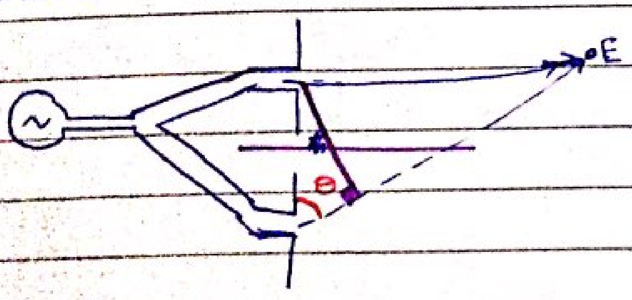
NFC ⇒ coupling induction.
look like a transformer.

$$\vec{E}_1 = \frac{E_{01}}{r} \sin\theta$$

$$\vec{E}_2 = \frac{E_{02}}{r} \sin\theta$$

$\boxed{1}$ if 2 signal coherenal → E_{01}, E_{02} ⇒ constant.
وصلو بنفس الوقت
depend on dimintion.

function generator.



$$\Delta d = D \cos\theta$$

$$\Delta\theta = \Delta d \frac{2\pi}{\lambda} = \frac{2\pi D}{\lambda} \cos\theta$$

$$\vec{E_2} = \frac{E_{01}}{r} \sin(\theta)\, e^{-j\Delta\theta}$$

$$\vec{E} = \underbrace{\frac{E_{01}}{r} \sin\theta}_{\text{R.P of one element.}} \underbrace{\left[1 + e^{-j\Delta\theta} \right]}_{A.F}$$

↳ AF = Array Factor

RP = Radiation Pattern.

AF ⇒ amplitude of electric field.

$$\boxed{AF = 1 + e^{-j\frac{2\pi D}{\lambda}\cos\theta}}$$

* بتقدر علاقة بين 2elements .

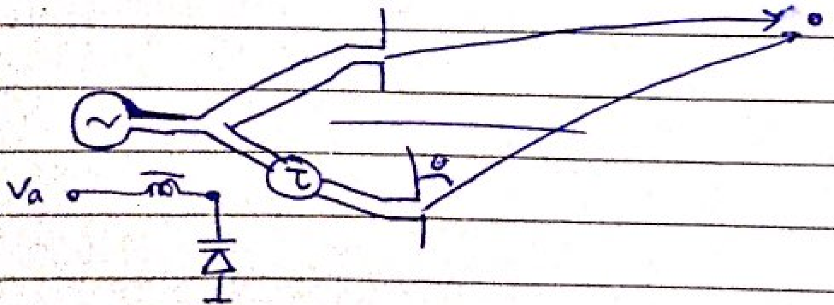
* correlation coefficient we assume $= 0$

2 are independent

↳ antenna.

→ ↑ correlation → ↓ AF.

$\boxed{2}$ add delay :-



$$\Delta\theta_{new} = \frac{2\pi D}{\lambda}\cos\theta + \frac{2\pi}{T}\tau$$

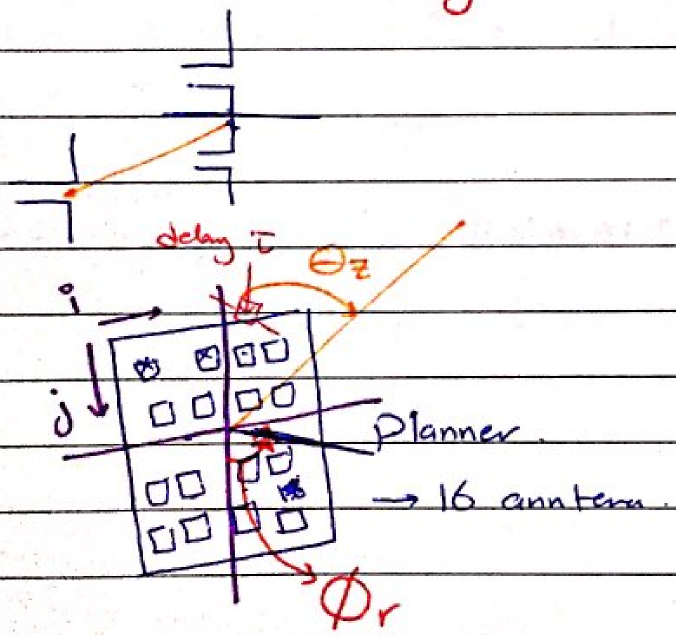
$$\boxed{AF = 1 + e^{j2\pi\left(\frac{\tau}{T} - \frac{D}{\lambda}\cos\theta\right)}} *$$

maximize when $\frac{\tau}{T} = \frac{D}{\lambda}\cos\theta$

$\uparrow \tau \rightarrow$ max $\theta \uparrow$

↳ Changing τ → can maximize θ.

* 2 diminitional array :-



$$AF = 1 + e^{j2\pi\left(\frac{\tau}{T} - \frac{D}{\lambda}\cos\theta\right)}$$

$$= e^{-j\pi(\quad)} + e^{j\pi(\quad)}$$

$$= 2\cos\left(\frac{\tau}{T} - \frac{D}{\lambda}\cos\theta\right)$$

$$\boxed{AF = 2\sum_{i}^{I/2}\sum_{j}^{J/2}\cos\left(\frac{\tau_{ij}}{T} - \frac{d_{ij}\cos\theta}{\lambda} - \frac{d_{ji}\cos\phi}{\lambda}\right)}$$

Maximum $\cos(0) = 1$

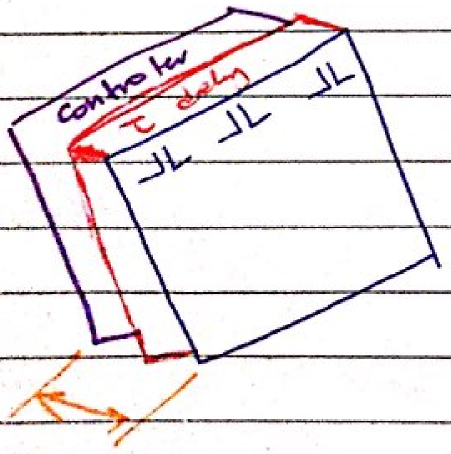
$$\frac{\tau_{ij}}{T} = \frac{d_{ij}\cos\theta}{\lambda} + \frac{d_{ji}\cos\phi}{\lambda}$$

$d_{ij} = d_{ji} = \lambda/2$

$$\boxed{\frac{\tau_{ij}}{T} = \frac{i}{2}\cos\theta + \frac{j}{2}\cos\phi}$$

$j \to J/2 \to$ 2cos كل وحدة عملت

$$\boxed{Max = I * J}$$

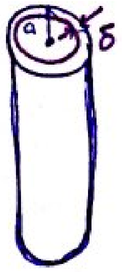


Smart Antenna
Beam Stearing
forming.

Short antenna → patch antenna

*Patch Antennas 84

18/4 WED

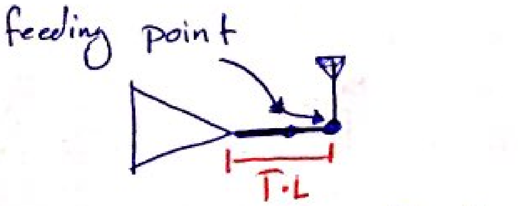


$$R_{\Omega} = \frac{l}{\sigma 2 \delta \pi \alpha}$$

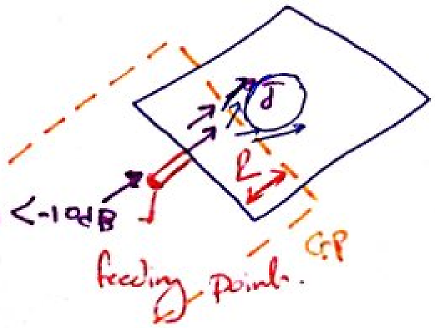
δ ≡ Skin depth

⇒Web antenna

- Small anntennn with respect to
- low gain *
- ~~om~~ omni - directional ⇒ radiation pattern.
  x-y → circule.



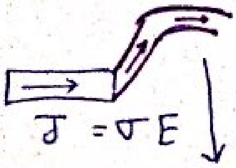
stander 50 Ω.
impedance



overlab
l ⇒ distance btw G.P and Patch anntenn.

input signal لا اقل يكون $S_{11} < -10dB$
↳ matching

* Ground Plane → to support radiation
↳ to Control the BW of anntenn.



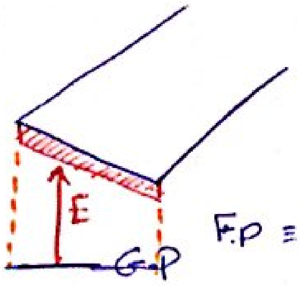
$J = \sigma E$

$\Sigma \vec{E}$

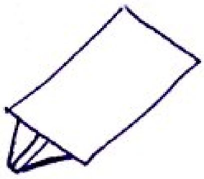
total $\vec{E}$

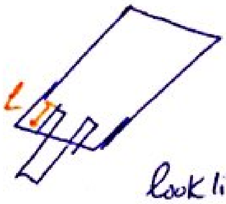
$$\boxed{\vec{E} = \int_{J} \frac{d\vec{J}(r,\theta,\phi)}{\sigma}}$$

line integral.

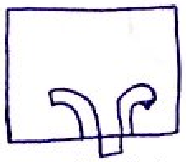


F.p ≡ feeding point.

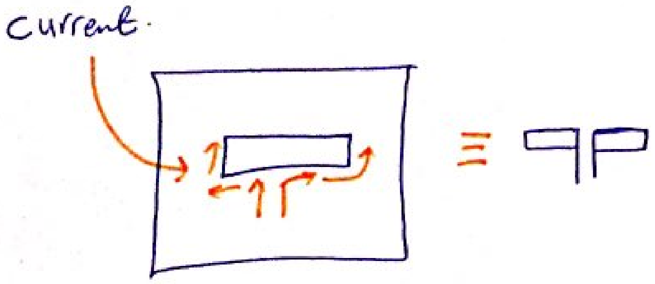




look like stub



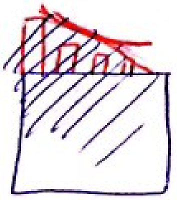
curved stub

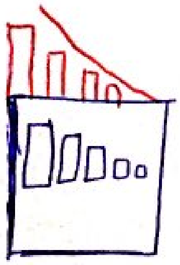


* tappering ⇒

→ increase operation of Antenna.

→ " BW.



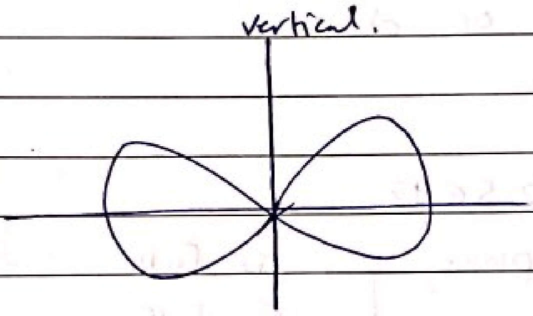


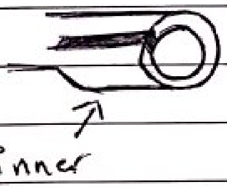
23/4 MON

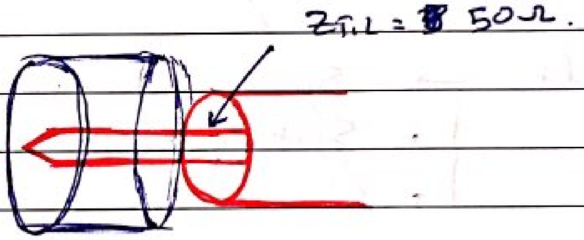
QUIZ 3

Draw the V-shape radiation pattern for a λ/4 monopole antenna.

Sol:

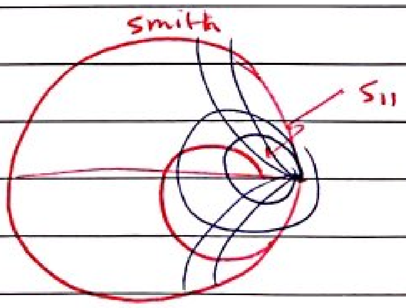






* Diode 1N4007

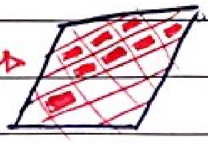
N-type



بدي BAND width ⟸ نرسم دائرة نصف
قطرها ٠,١٠٣ (cm)
convert to.

ونقاط اي داخل الدائرة ، بتقاطع معهم عند
اول واخر نقطة هم الـ BW .

current distribution in ground plane →



Serch ⇒ GPS Reciver antenna

Project :

Design a patch antenna using ADK in HFSS

ترسم اسلاك داخل ال patch antenna

freq = 2.5 GHZ.

↳ change X . for ground plane → X full
↳ X half.

result → S_{11}
↳ smith chart
↳ إي بتشبه ال donout.

* التسليم الاثنين 30/4 ☺

25/4 WED

QUIZ 4

What are the effect of ground plane on the patch antenna ?!

Sol:

control the BW

- a patch antenna in the x-y plane with full G.P does the R.P exist in the -ve z-direction ?! why ?!

Sol:

Yes → if thin → current distripution on patch anntena بعمل ع جهة ثانية

بشوف صورته وراه .

No → thick.

↓

ما بنقدر نشوفو من جهة ثانية .

بيعمل

sheilding

Q↓ → BW↑

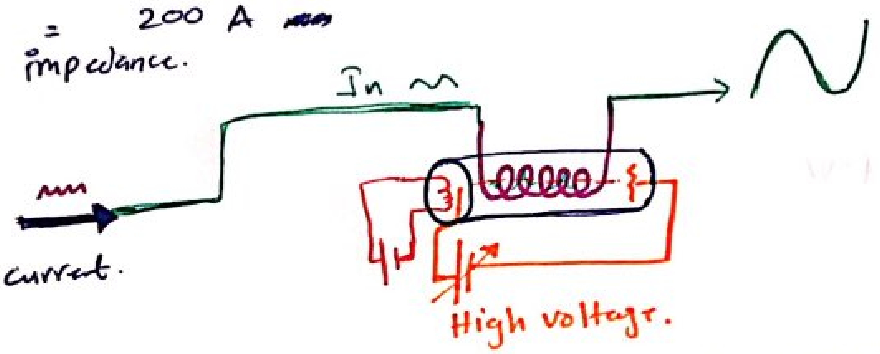
↳ $\boxed{R}$ in the path of circuit → losses.

I^2R → Noise.

↳ $\boxed{L}$ → coupling effect عالي

TWT : Troubling wave . tube.

$\frac{10KW}{50 \rightarrow \text{impedance.}} = 200\ A$



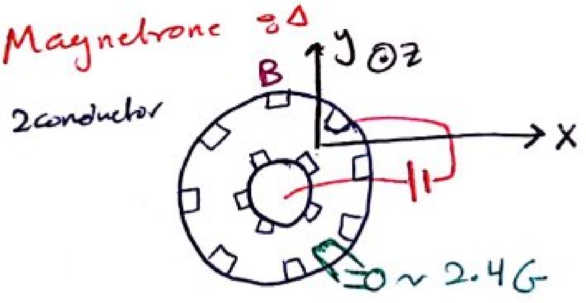
change high voltage → to change electron beam → current

* coherent with external signal

TWT ⇒ use electric force to modulate the current using Input signal.

for High oscillator ⇒ we use Magnetrone

Magnetrone :



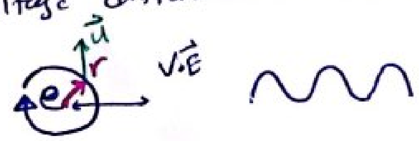
force ⊥ xy plane

for transition
for electric field ⊙
out

if connect volt → electric field → edges

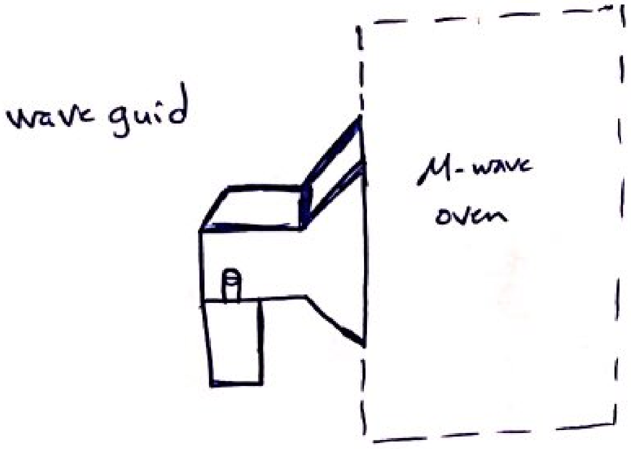
& b magnetic field

Voltage difference → reduce magnetic field.



↑ voltage → ↑ force

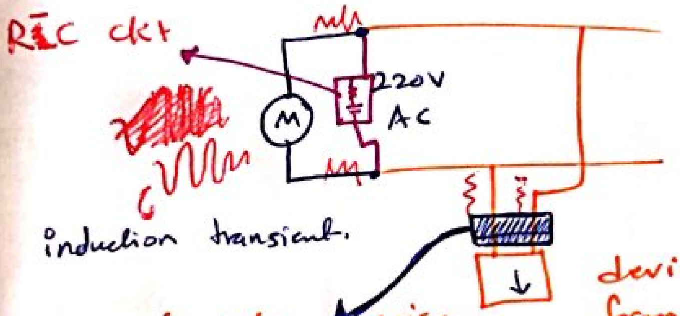
can select the frequency → ~~[illegible]~~ ~~[illegible]~~ tuning
mechanical



→ electron magnatic compatability 8

↳ matching btw input, output.

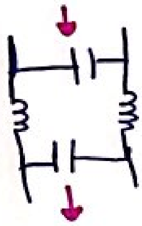
↳ power lines



isoulate using filter

device from powe supply side

↳ very narrow Band pass filter



sheilding → size device
↳ device كم بدنا نعزل
عن عالم خارجي

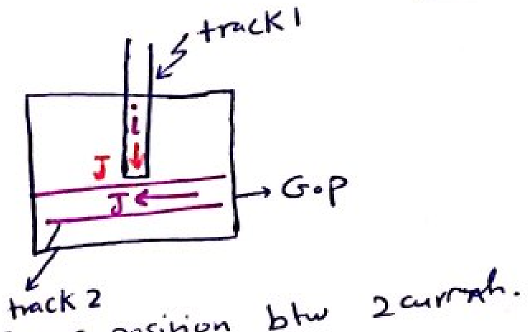
① electric → current ما يبين
للخارج

② magnatic

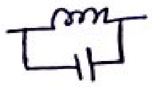
30/4 MON

EMI :4

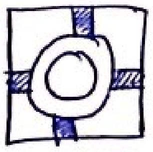
- Radiation
- Coupling
- G.L ≡ ground Loop



↳ Super position btw 2 currents.

Via → parallel LC circuit 

نستخدمها في Groundplane بكون ناقص
not continous connection with ground plane.



to create

Via in powersupply have 2 effect → thermal effect.
→

G.L → more than one voltage.
Qo → 0V → dual polarity amplifier orckt.

Low Drop Out ≡ LDO regulator.
input 3.7 → output 3.3

IC → C = 100nF

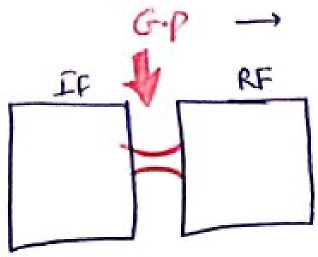
100n → tanck

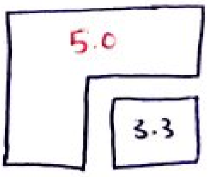
LC محتاج تيار باشد
C

↳ reset (no enough current to drive it)

69

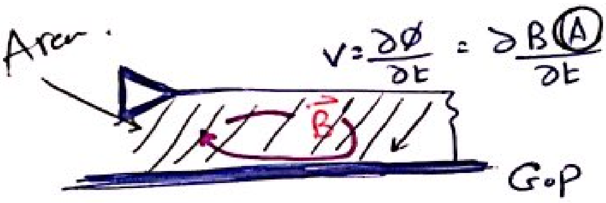
G.P → شبكتين عشان يصير عندي G.L





Coupling → 2 current have 2 magnetic field. → induce voltage. at point.

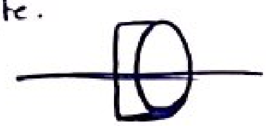
$v = \frac{\partial \phi}{\partial t} = \frac{\partial B \textcircled{A}}{\partial t}$



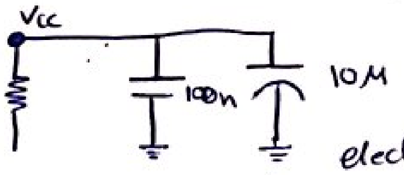
* [redacted] [redacted]

↳ Area ↓ → induced voltage ↓

Ferrite.



$\mu_r > 15K$

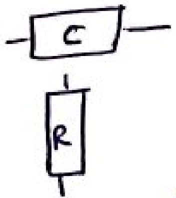


electro light → charge بزيد

↓

تقلل ال Slow variation for voltage.

μs → long time

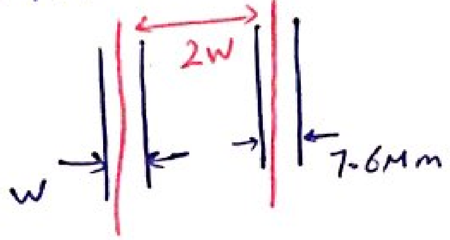


* تشيل ال $C, R(\perp)$ → thermal coupling — أقل ما يمكن — أبعد

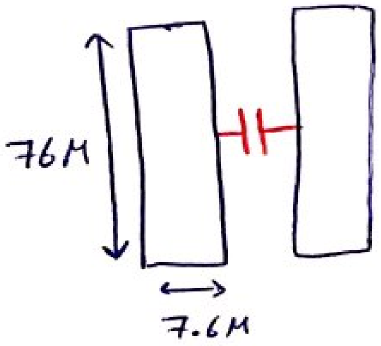
[redacted] [redacted]

[redacted]

WTW rule =>



high → 30mile = 76M.

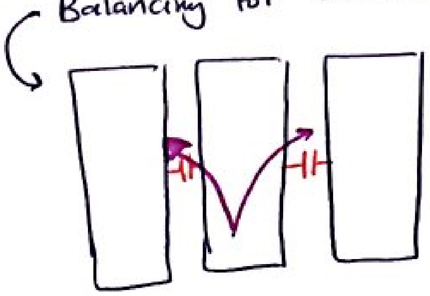


Capacitance ↑

high >> width.

Guide for electron → track

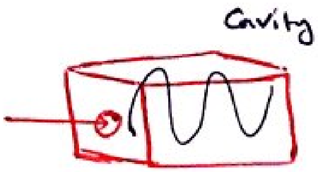
Balancing for current.



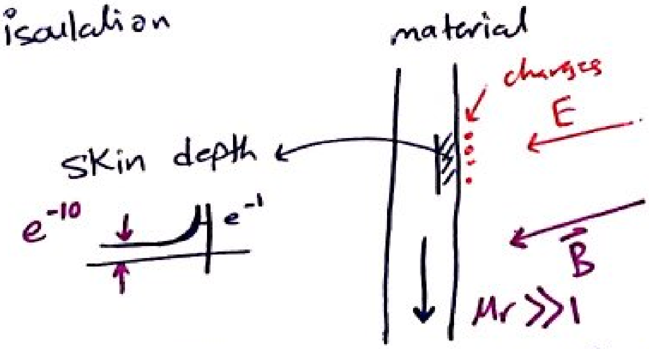
Radiation:-

have regulation for Radiation.

↳ external
↳ internal

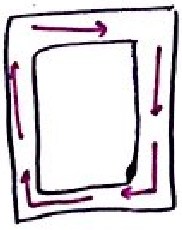


isaulation



IL → Insertion loss   log S21

$$\boxed{IL \geq 40dB}$$



$\mu_r >> 1$
$\sigma \uparrow$ → (iron) best material

2/15 WED

Quiz 5

a PCB trak with loop area with the ground = 10mm²

Find the external magnetic field that indices a 15 Volt at the terminal at f = 1GHZ.

Sol:-

$$V_{mf} = -N \frac{d\phi}{dt}$$

$\boxed{N = 1 \rightarrow \text{one loop}}$

$V = A . \text{area} \ w$

$15 = A * 10 \times 10^{-6} . 2\pi \times 10^{9}$

$A = 238.7 \ \mu T$

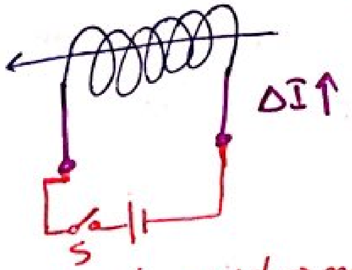
$\boxed{A = 238 \ \mu T}$

worest case → Maximum
لما يكون ماكسيمم ال cos

$\sim d^{-\delta}$ asafunction of distance.

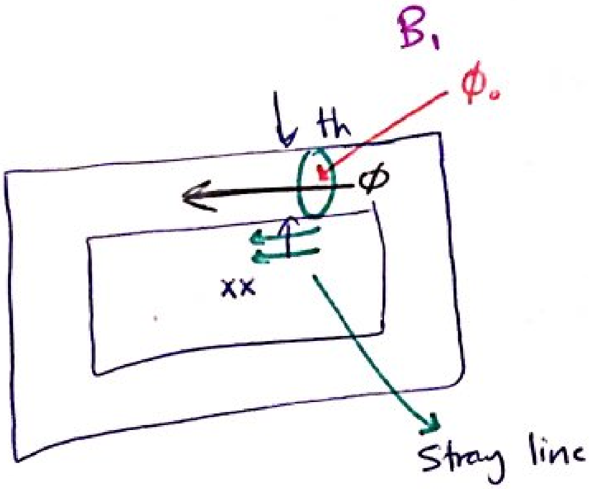
* Durty bumps Δ

$B = \mu I n$



closed switch → magnetic field impulse.

* magnatic filed → current → elections or proton.

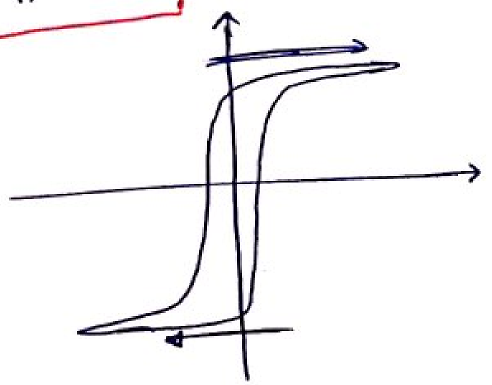


th ≡ thickness

thickness↑ → cross section Area ↑

in saturation point → ohmic effect. ← magnetic field بتحصل كل

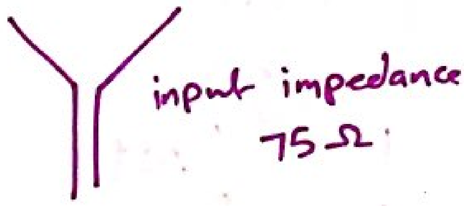
B-H curve



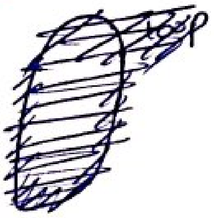
↑freq → ↑T (بتسخن)

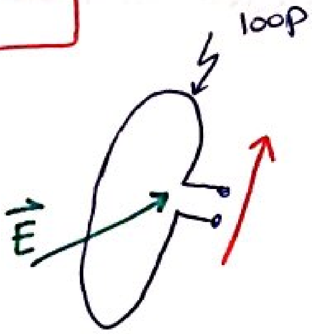
↑Area → ↑T

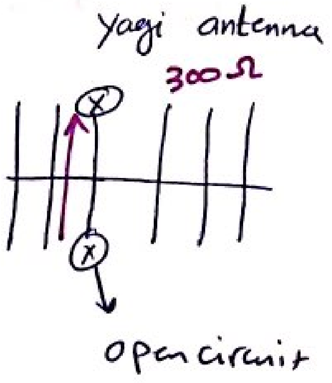
*



$$\boxed{V=\int E\cdot dl}$$







THE END