EM2

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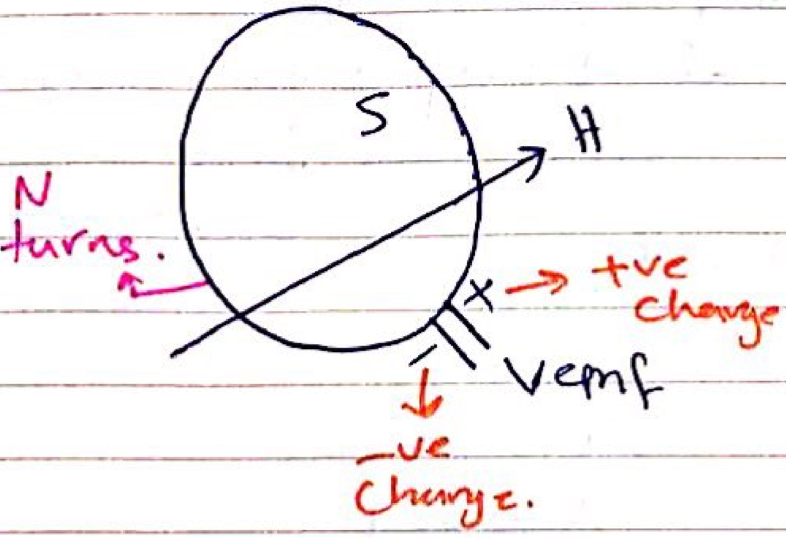


$F = q\,(u \times B)$

Charge ال حركة

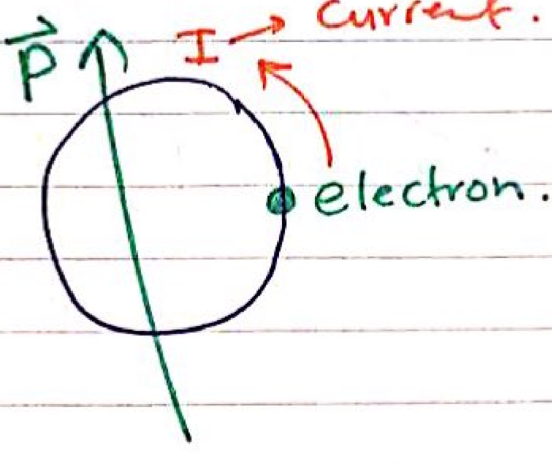
$F \perp B$

$F \perp u$

$V_{emf} = \frac{\partial \lambda}{\partial t} = -N \frac{\partial \Psi}{\partial t}$ → flux.

$\Psi = \int B \cdot ds$ ⇒ in closed surface $\simeq 0$

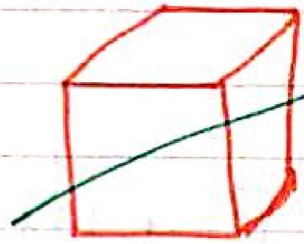
$I\,(L \times B)$



$\Psi = \int B \cdot ds$

$= \int \mu H \cdot ds = \int \mu K I\, ds.$

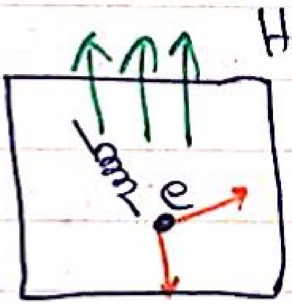
K → constant.



H (magnatic field)

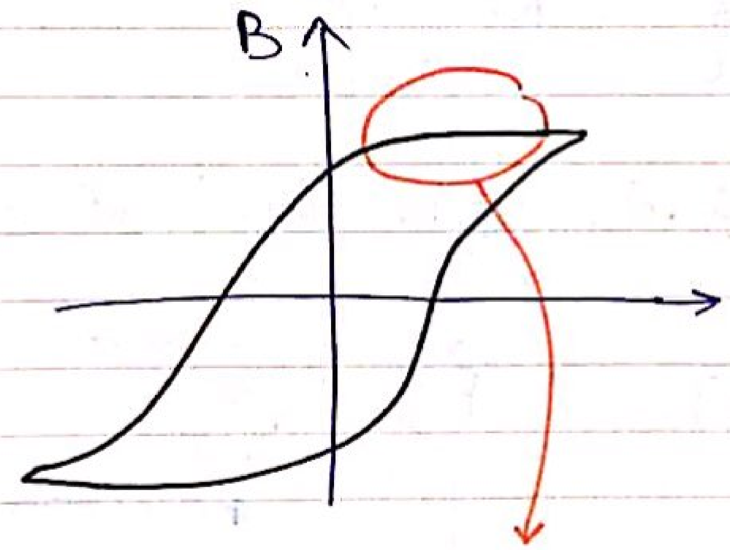
at $t = 0$ → time varying
↳ force on electrons.

H internal.



$\mu = \mu_0 \mu_r$

$\mu_r \geq 1$



Hysterisis loop.

H < +ve, -ve
up and down

rise H ↑ → use the transformer pulse width modulation.

↑ f , Chang H.

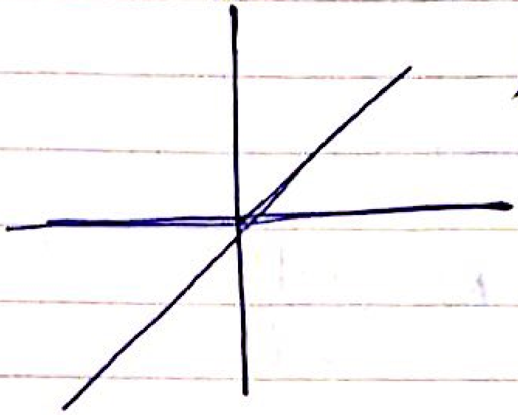
and gate.

* from low to high ON] differential btw volt
" high " low OFF]

⇒ Noise margin.

/ /

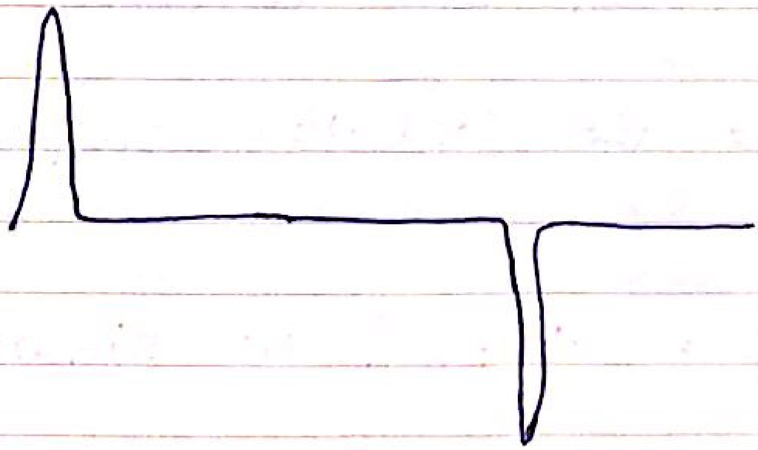
↑ area → ↑ loss in energy.



linear H.L

$H = H_0 \sin(\omega t)$.

$\frac{\Delta I}{\Delta t}$.



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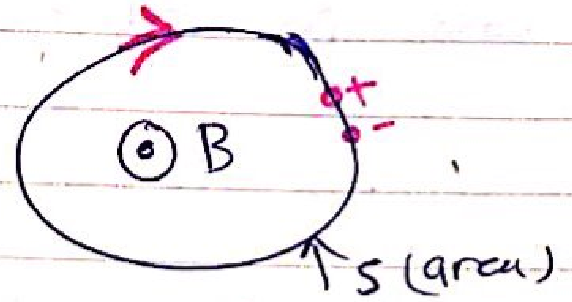
Ex



$$V_{emf} = \frac{-\partial \lambda}{\partial t} = -N \frac{\partial \Phi}{\partial t}.$$

* اذا لفيت الـ coil بشكل عشوائي حيكون في فرق بين أول لفة وأخر لفة ⇐ بصير عندي break down.

"break down btw different coil in a loop"

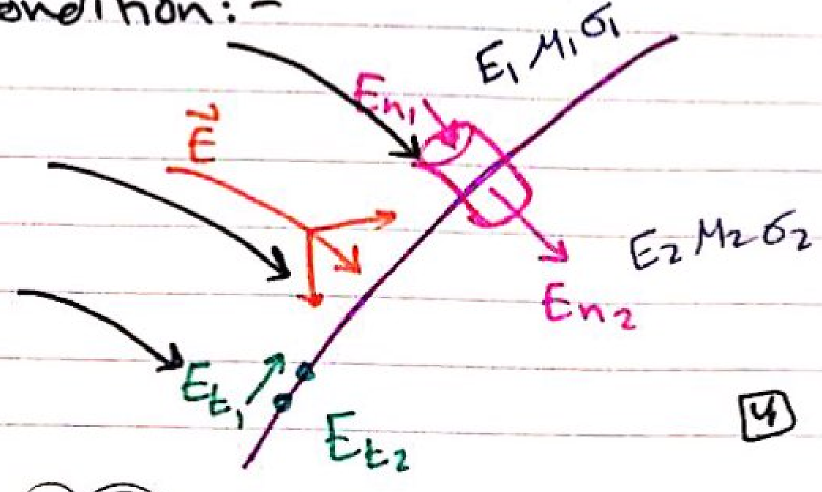
$B = B_0 \cos(\omega t)$ simple harmonic function.

$V_{emf} = + B_0 S \omega \sin(\omega t)$

B متغير

~~[illegible]~~

* Boundary condition:-



$$E_{t_1} = E_{t_2}$$

* يمر فيهم ⟵ magnetic field
electric "

قسم الـ $\vec{E}$ لأي مكان إلى
normal
tangent.

$$\vec{J} = \sigma \vec{E}$$

* إذا في تيار بتولد electric field, بالتالي موجود.

* In the transient → electron move on component → produce current → after relaxation time → remove tangent and normal بعدين

normal component: (in area).

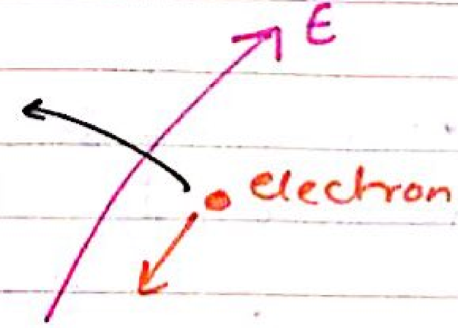
$$\int D_{n1}\, ds = q_{inside}$$

$$-D_{n1} + D_{n2} = \frac{q}{S} = \rho_s$$

$$D_{n2} - D_{n1} = \rho_s$$

$\varepsilon \uparrow \rightarrow \vec{E} \downarrow \rightarrow \uparrow$ capacitance.

الإلكترون داخل الـ $\vec{E}$ و بعاكس اتجاهها

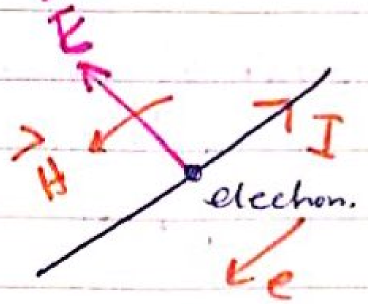


* Capacitor ⇒ بعمل الـ breakdown voltage.

$$\nabla \times E = -\frac{\partial B}{\partial t}.$$

$$\nabla \times H = J + \frac{\partial D}{\partial t}. \rightsquigarrow \vec{E} \cdot \varepsilon_0$$

$$E = E_0 \cos(\omega t)$$



$$\nabla \times H = \varepsilon \frac{\partial \vec{E}}{\partial t}.$$

$$\nabla \times H = \varepsilon \frac{\partial E}{\partial t}.$$

$$\nabla \times E = -\mu \frac{\partial H}{\partial t}.$$

$E = g(\alpha) \Rightarrow (t_1, \underline{x, y, z}) \propto \beta$

↑ time ↳ space.

$E = g(\beta)$

$= \cos(\beta)$

$= \cos(at + B(x, y, z))$.

$= \cos(\omega t - kr)$

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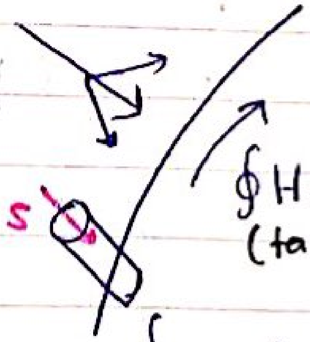
$H_{t_1} - H_{t_2} = -K$

wave equation:



$E = E_0 e^{-\alpha r} \cos(\underbrace{\omega t - \beta r}_{\phi}) \vec{a_e}$

$H = H_0 e^{-\alpha r} \cos(\omega t - \underline{\beta r}) \vec{a_h}$

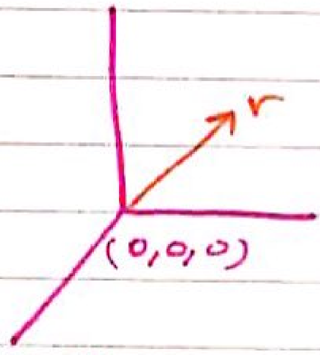
phase shift ←

$\oint H \cdot dL = I$ (tangent)

$\oint B \cdot ds = 0$ (normal)

$B_{n_2} = B_{n_1}$

* مش الـ vector ← complex quantity.



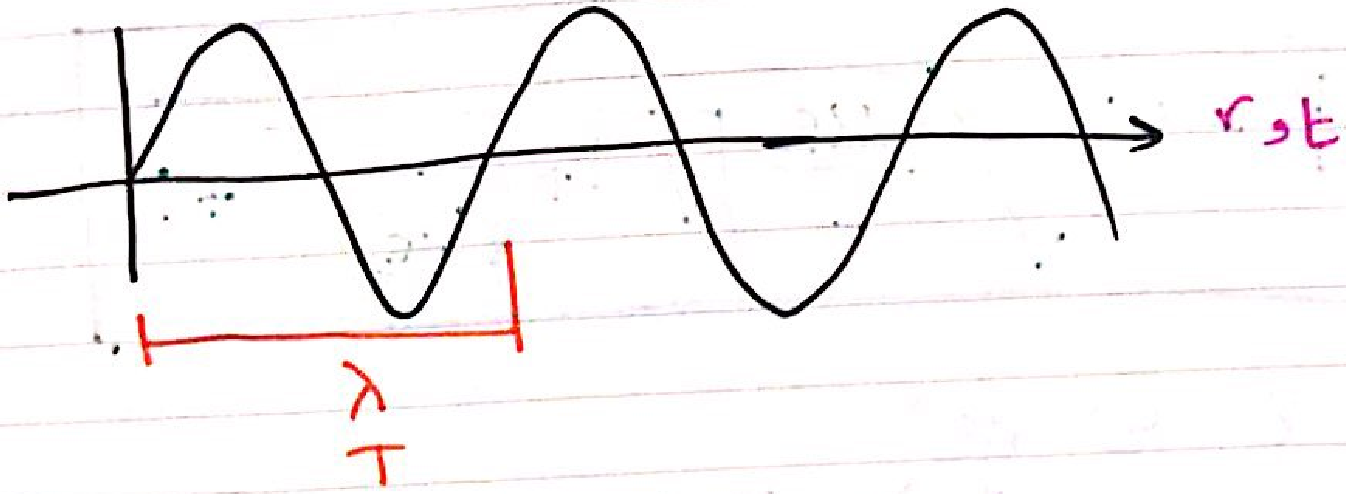
$\vec{a_e} \times \vec{a_h} = \vec{a_r}$

اتجاه r باتجاه magnetic field.

phasor in (r) direction not in E or H field.

* phase ~~[illegible]~~ ما الو علاقة بـ ~~direction~~ direction x, y

* اتجاه ~~[illegible]~~ electric, magnetic ما الو علاقة باتجاه ال propagation.



$$\beta = \frac{2\pi}{\lambda} \qquad \omega = \frac{2\pi}{T}$$

$\alpha \uparrow \longrightarrow E \downarrow \rightsquigarrow \alpha \approx 0$

عشان يكون عندي قيم لل E .

if $\alpha \approx 100 \quad e^{-100} \rightsquigarrow E \approx 0.$

$$\nabla^2 E - \gamma^2 E = 0.$$

$$\gamma^2 = (\sigma + j\omega\varepsilon)\, j\omega\mu$$

$$= \alpha + j\beta$$

$$\alpha = \omega \sqrt{\frac{\mu\varepsilon}{2}\left[\sqrt{1 + \left(\frac{\sigma}{\omega\varepsilon}\right)^2} - 1\right]}$$

$$\beta = \omega \sqrt{\frac{\mu \varepsilon}{2}\left[\sqrt{1+\left(\frac{\sigma}{\omega \varepsilon}\right)^2}+1\right]}$$

$\varepsilon = \varepsilon' + j\varepsilon''$ → effect of break down.

$\mu = \mu' + j\mu''$ → heat or real powr. distmated in the material.

ε'' → in water « قيمتها بتكون عالية. »

loss tangent $= \frac{\sigma}{\omega \varepsilon}$

$$E = \eta . H$$

η = Characteristic Impedence of Space.

$$\eta = \sqrt{\frac{j\omega\mu}{\sigma + j\omega\varepsilon}} = |\eta| \angle \theta_\eta$$

* Speed of propagation in r direction.

$$u = \frac{1}{\sqrt{\mu \varepsilon}} = \frac{1}{\sqrt{\mu_o \mu_r \varepsilon_r \varepsilon_o}} = \frac{c}{\sqrt{\varepsilon_r \mu_r}}$$

$$\frac{2\pi t}{T} = \frac{2\pi}{\lambda} r$$

$$\frac{\lambda}{T} = \frac{r}{t} = u$$

[$\frac{\text{distance}}{\text{time}}$ = speed

$\frac{1}{T}$ = freq]

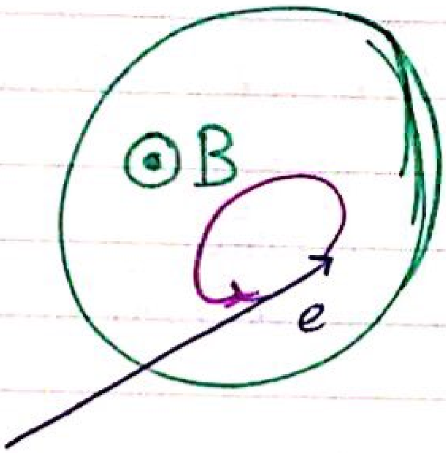
$$c = \frac{1}{\sqrt{\mu_o \varepsilon_o}} = 3 \times 10^8 \text{ m/s}.$$

$$\tan(2\theta_\eta) = \frac{\sigma}{\omega \varepsilon}$$

$\sigma = 0 \rightarrow \eta \Rightarrow$ complex

↳ special case. $\alpha = 0$.

/ /



* عندي magnetic field لما احط فيها electron بيدور داخل ال magnetic field.

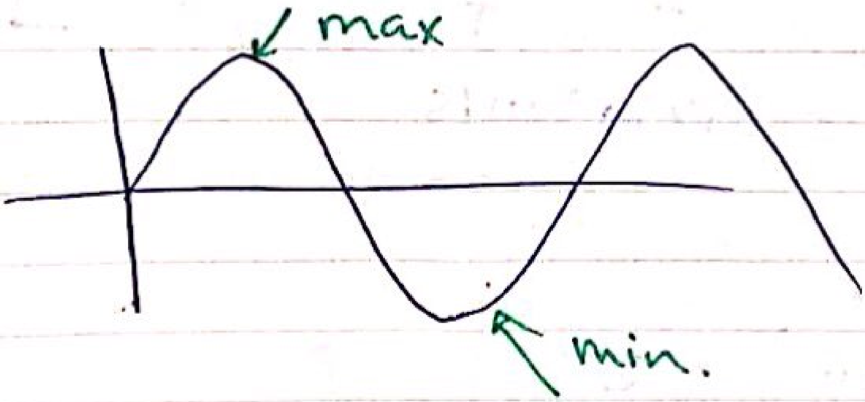
$V=E.dl$

ولما احط سلك جنب ال magnetic field

⇓

عا يقرب ال e من السلك يعطيني max

" يبتعد ال e " يعطي min.



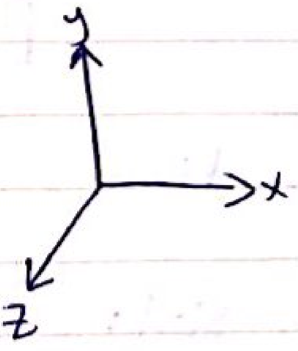
* ما عندي pure sinusoidal لانو not coherent ما بطلعهم بنفس اللحظة.

26 / 7
Wed.

Ex

$E = E_o\, e^{-\alpha r} \cos(\omega t - \beta r)\, \vec{a_x}$

$E = E_o\, e^{-\alpha z} \cos(\omega t - \beta z)\, \vec{a_x}$
↳ unit (volt / meter)



$H = H_o\, e^{-\alpha z} \cos(\omega t - \beta z)\, \vec{a_y}$

elect ⊥ magnetic field. field

$H_o \rightarrow \frac{E_o}{\eta}$

$H = \frac{E_o}{\eta} e^{-\alpha z} \cos(\omega t - \beta z)\, \vec{a_y}$
↳ unit (amber/meter)

$\bar{P}$ power or average Pointing

اتجاهها نفس اتجاه الـpropegation.

$\vec{P} = \vec{E} \times \vec{H}$

$$\bar{P} = \frac{1}{2} |E||H|$$ w/m² «power density»

/ /

Ex $\sigma = 0.01$, $\varepsilon_r = 4$, $\mu_r = 1$

$E_0 = 10\,V/m$, $f = 6\,GHz$

E in +ve x direction ⟹ ($-\beta$)

P in +ve z direction

Find: u, λ, η, α, β, $\overline{P}$

Sol: $\mu_0 = 4\pi\times10^{-7}$

$\varepsilon_0 = 8.85\times10^{-12}$

① $u = \dfrac{c}{\sqrt{\mu_r\varepsilon_r}} = \dfrac{3\times10^8}{\sqrt{4\cdot1}} = 150\times10^6$

② $\lambda = \dfrac{u}{f} = \dfrac{c/2}{6\times10^9} = 0.025 = 2.5\,cm$

③ $\alpha = \omega\sqrt{\dfrac{\mu\varepsilon}{2}\left(\sqrt{1+\left(\dfrac{\sigma}{\omega\varepsilon}\right)^2}-1\right)}$

$\dfrac{\sigma}{\omega\varepsilon} = \dfrac{10^{-2}}{\underbrace{4}_{\varepsilon_r}\times\underbrace{2\pi\times6\times10^9}_{\omega=2\pi f} * \underbrace{8.85\times10^{-12}}_{\varepsilon_0}} = 7.49\times10^{-3}$

$\omega = 2\pi f$

$\alpha = \dfrac{\omega}{u}\sqrt{\dfrac{1}{2}\left(\sqrt{1+\left(\dfrac{\sigma}{\omega\varepsilon}\right)^2}\mp1\right)}$

$\alpha = 0.9341$

④ $\beta = 251.5$

⑤ $\eta = \sqrt{\dfrac{j\omega\mu}{\sigma + j\omega\varepsilon}} =$ [illegible]

$$\eta = \frac{\eta_0}{\sqrt{\varepsilon_r}} = \frac{120\pi}{\sqrt{4}} = 188.5$$

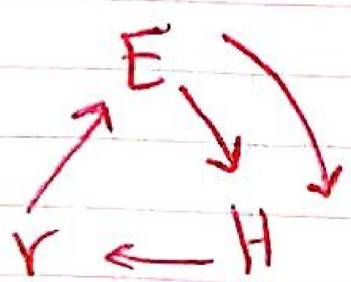
$$\eta = 188.5 \angle \tfrac{1}{2}\tan^{-1}(7.5\times10^{-3})$$

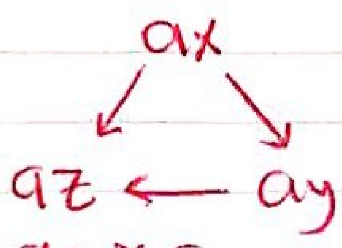
$$= 188.5 \angle 0.215^\circ$$

⑥ [illegible]

$$\bar{P} = \frac{1}{2}\frac{E_0^2}{\eta} = \frac{1}{2}\cdot\frac{(10)^2}{188.5}$$

$= 0.265$ watt / meter.





$a_x \times a_y = +ve\ a_z$

$a_y \times a_x = -ve\ a_z$

Quiz1 Find pointing vector. in free space if:

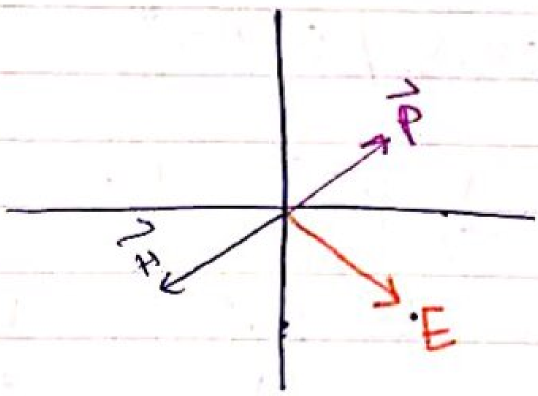
$E = 8 \cos(wt - Br) . \vec{a_y}$

$H = H_o \cos(wt - Br) a_x$

$P = -\frac{64}{377} \vec{a_z}$

② Find $\vec{H}$:

$E = 10 . \cos(w.t + Bz)\left(\frac{1}{\sqrt{2}} \vec{a_x} - \frac{1}{\sqrt{2}} \vec{a_y}\right)$



$\vec{H} = \frac{10}{377} \cos(wt + \beta z) \left(\frac{-1}{\sqrt{2}} \vec{a_x} - \frac{1}{\sqrt{2}} \vec{a_y}\right)$

* (∫) solution more stable.

Ex $\alpha = 0.94$

$\beta = 251.4$

$\eta = 188.5 \angle 0.215°$

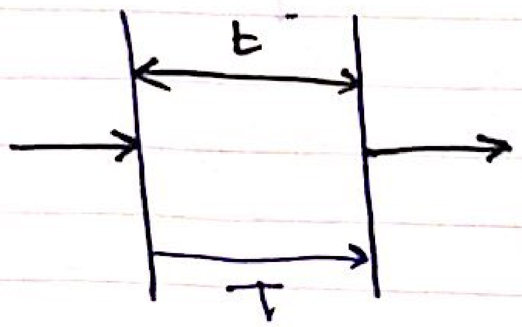
$u = c/2$

$\lambda = 2.5\ cm.$

$E = 10\, e^{-\alpha z} \cos(\omega t - \beta z)\, \vec{a_x}$

$H = \frac{10}{188.5}\, e^{-\alpha z} \cos(\omega t - \beta z - 0.215°)\, \vec{a_y}$

$\vec{P} = \frac{100}{188.5}\, e^{-2\alpha z} \cos(\omega t - \beta z) \cos(\omega t - \beta z - 0.215)\, \vec{a_z}$



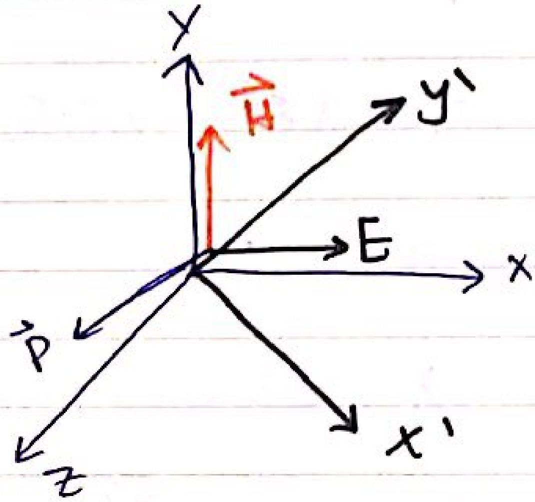
Ex

$E = 10 \cos(\omega t - \beta z)\, \vec{a_x}$

$H = \frac{10}{377} \cos(\omega t - \beta z)\, \vec{a_y}$

$\eta_0 \leftarrow 377$

$\begin{cases} \varepsilon_0, \mu_0 \\ u = C \end{cases}$



$V = V_x \vec{a_x} + V_y \vec{a_y} + V_z \vec{a_z}$

$R = \begin{bmatrix} \cos & \sin \\ -\sin & \cos \end{bmatrix}$

rotation matrix in 3 dimention space.

$V' = \vec{V} R$

[Ex] $E = 10\cos(\omega t - \beta z)\vec{a_x} + 5\cos(\omega t - \beta x)\vec{a_y}$

$H = \frac{10}{377}\cos(\omega t - \beta z)\vec{a_y} + \frac{5}{377}\cos(\omega t - \beta x)\vec{a_z}$

↳ 2 waves (independent).

* wave polarization :-

(1) linear :- "Space ال في elect field مسار"

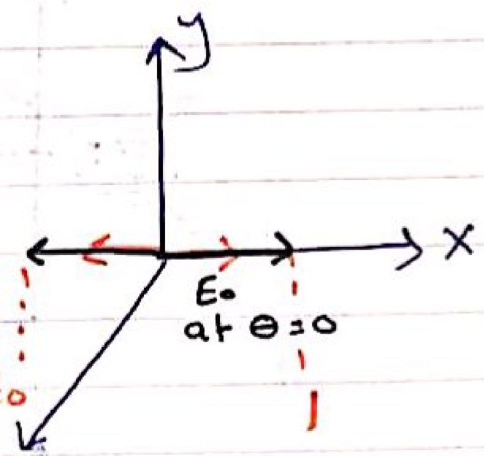
$E = E_o \cos(\underbrace{\omega t - \beta z}_{\theta})\vec{a_x}$

$\theta = 0$

$E =$

at $\theta = 45$

$E = \frac{E_o}{\sqrt{2}}$.

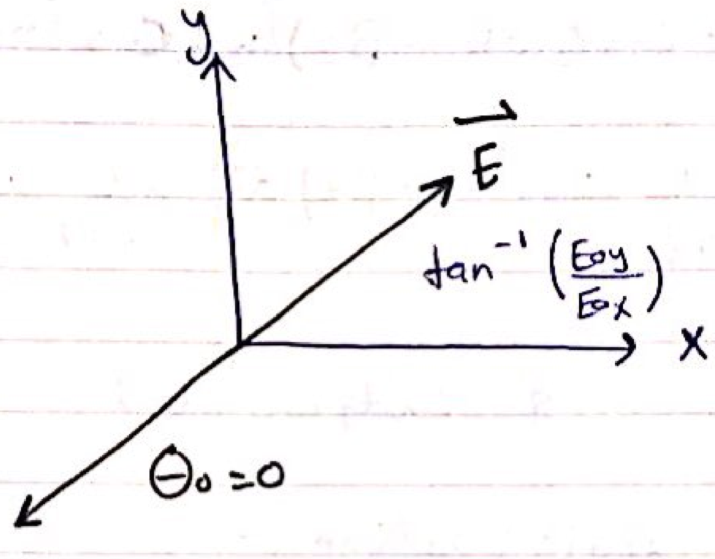


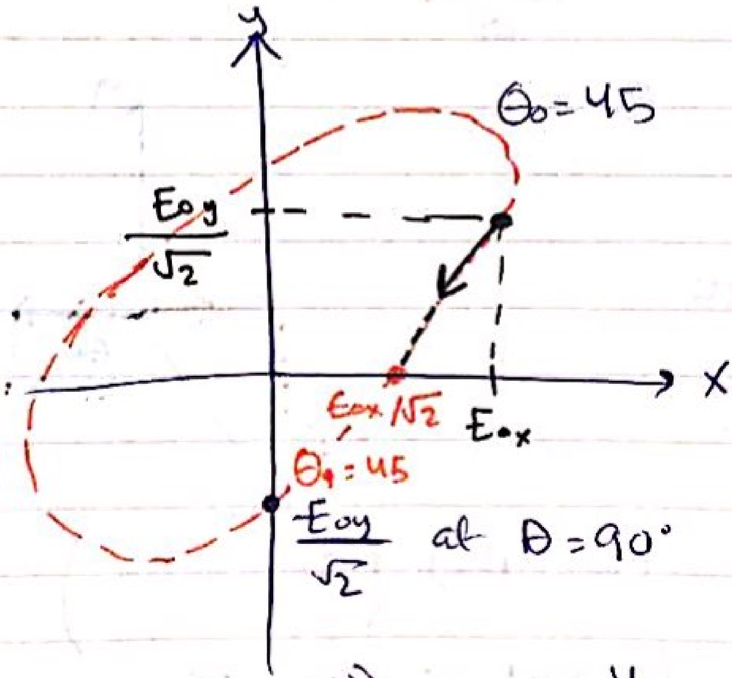
$E = E_o \cos(\omega t - \beta z)\left(\frac{\vec{a_x}}{\sqrt{2}} + \frac{\vec{a_y}}{\sqrt{2}}\right)$

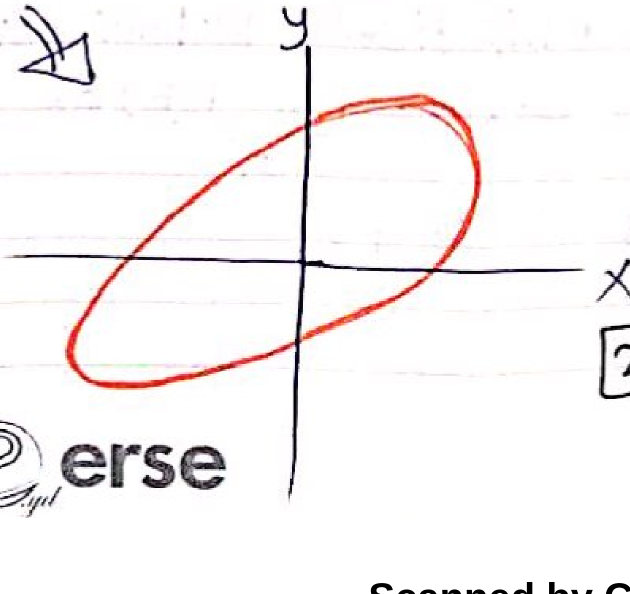
3- elliptical polarization :-

$\vec{E} = E_{ox}\cos(\underbrace{\omega t - \beta z}_{\theta})\vec{a_x} + E_{oy}\cos(\underbrace{\omega t - \beta z + \theta_o}_{\theta + \theta_o})\vec{a_y}$

$\theta_o = 45$

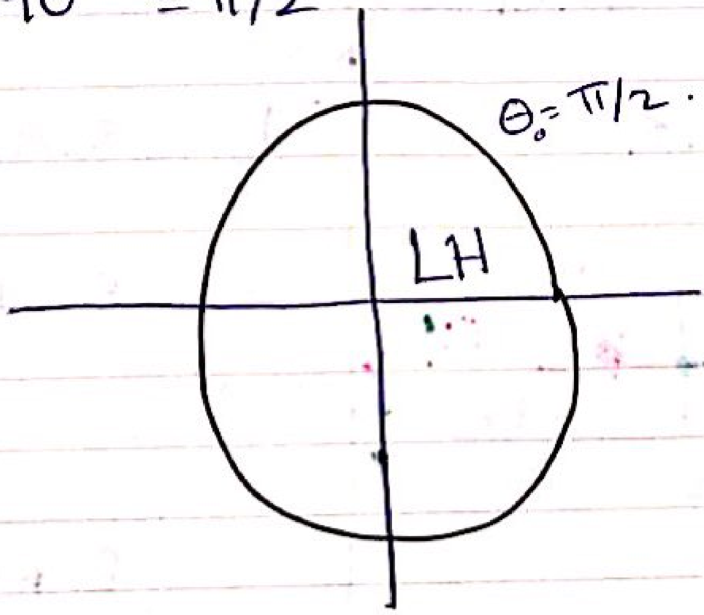

y
E
tan⁻¹ (Eoy / Eox)
x
θ0 = 0


y
θ0 = 45
Eoy / √2
x
Eox / √2
Eox
θ1 = 45
Eoy / √2 at θ = 90°


y
x

/ /

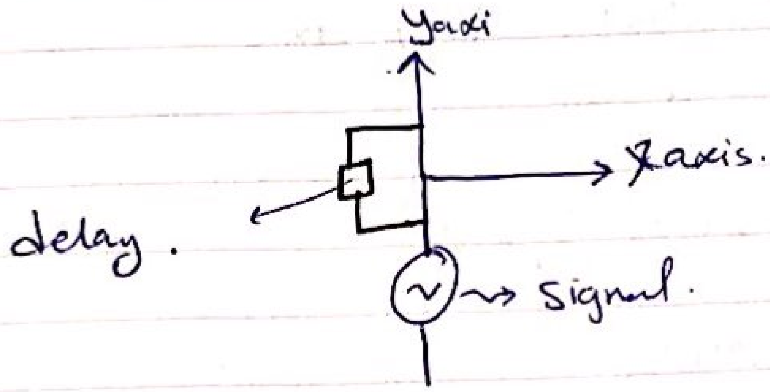
at $\Theta_o = 90° = \pi/2$



LH ≡ left Hand.

[2] Circular Polarization :-

$\Theta_o = \pi/2$.



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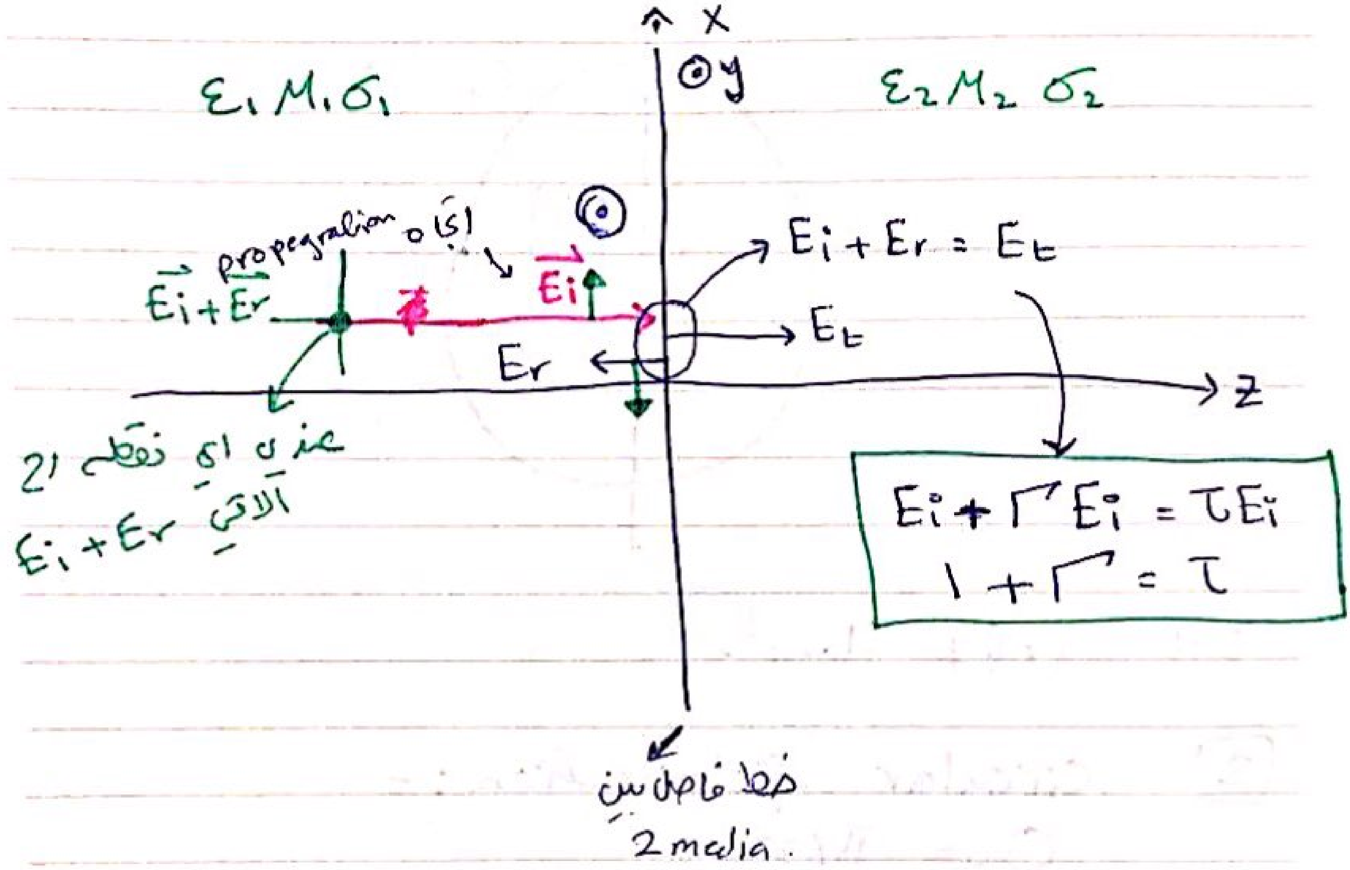
* Normal Incident 8◁



$$E_i + \Gamma E_i = \tau E_i$$

$$1 + \Gamma = \tau$$

$$E = E_o \, e^{-\alpha z} \cos(\omega t - \beta z) \, \vec{a_x}$$

at loss less $\alpha = 0$.

$$E_i = E_o \cos(\omega t - \beta_1 z \, \vec{a_x}$$

$$\Rightarrow \beta_1 = \omega \sqrt{\mu_1 \varepsilon_1}$$

$$\Rightarrow \lambda_1 = \frac{u_1}{f}$$

الاشاره ٥ راح ينعكس جزء منها و يمر جزء منها .

$E_r = \Gamma E_i$

$E_t = \tau E_i$

$$\Gamma = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1}$$

$$\tau = 1 + \Gamma$$

$$\tau = \frac{2\eta_2}{\eta_2 + \eta_1}$$

$\eta = \sqrt{\frac{\mu}{\varepsilon}}$ at lossless . $\sigma = 0$

Ex free space
- → $\sigma = 0$
- → $\varepsilon_{r_1} = 1$
- → $\mu_{r_1} = 1$

media 2
- → $\mu_{r_2} = 1$
- → $\varepsilon_r = 4$
- → $\sigma_2 = 0$

Sol:

$\eta_1 = \eta_0 = 120\pi = 377\ \Omega$.

$\eta_2 = \sqrt{\frac{\mu}{\varepsilon}} = 60\pi$

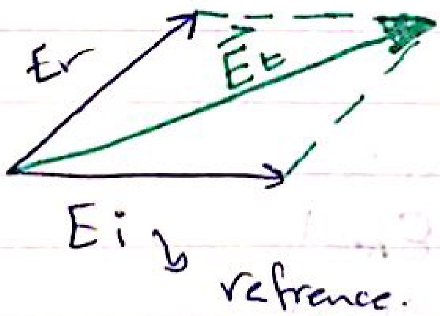
reflected $\Gamma = \frac{60\pi - 120\pi}{180\pi} = -\frac{6}{18} = -\frac{1}{3}$

$\downarrow$ 180° يعني

$E_r = \frac{-1}{3} E_i$

for amplitude.

$= \frac{-E_o}{3} \cos(\omega t + \beta_1 z)\,\vec{a_x} \Rightarrow -ve\ \vec{a_x}$



transmitted $\tau = \frac{2}{3}$, $E_t = \tau E_i$.

$E_\tau = \frac{2}{3} E_o \cos(\omega t - \beta_2 z)\,\vec{a_x}$

$-1 < \Gamma < +1$

$0 < \tau < 2$

$\lambda_1 = \frac{c}{f}$

$u = \frac{1}{\sqrt{\mu \varepsilon}}$

$\lambda_2 = \frac{c/2}{f}$

$\rightarrow B_2 = 2 B_1$

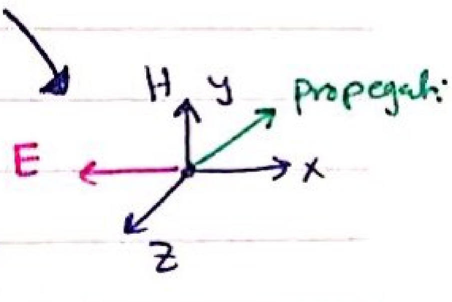
free space

$H_i = \frac{E_o}{\eta_o} \cos(\omega t - B_1 z) \vec{a_y}$ ✓

$H_r = \frac{\frac{1}{3} E_i}{\eta_o} \cos(\omega t + B_1 z) \vec{a_y}$

media 2

$H_\tau = \frac{2 E_o}{3 \eta_2} \cos(\omega t - B_2 z) \vec{a_y}$

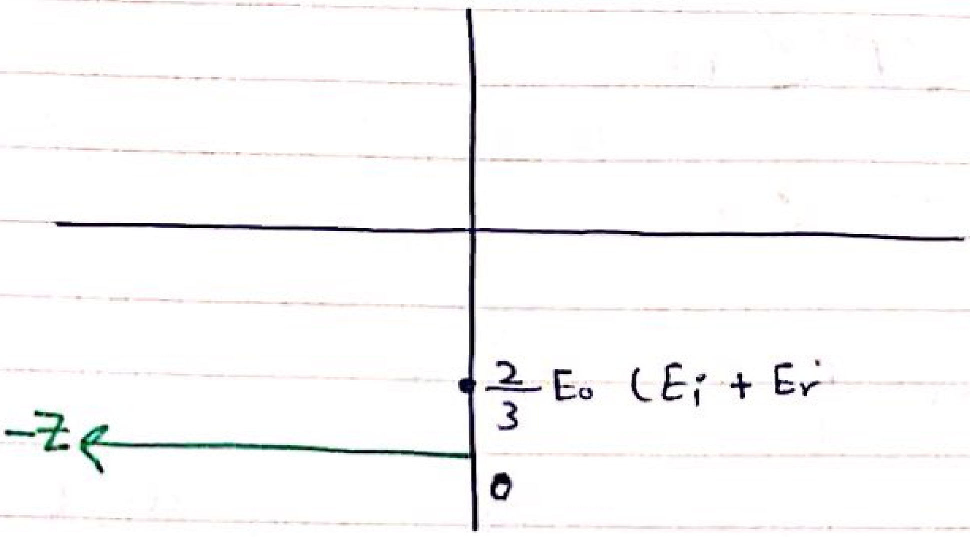


E → −x axis.

Γ → −ve z.

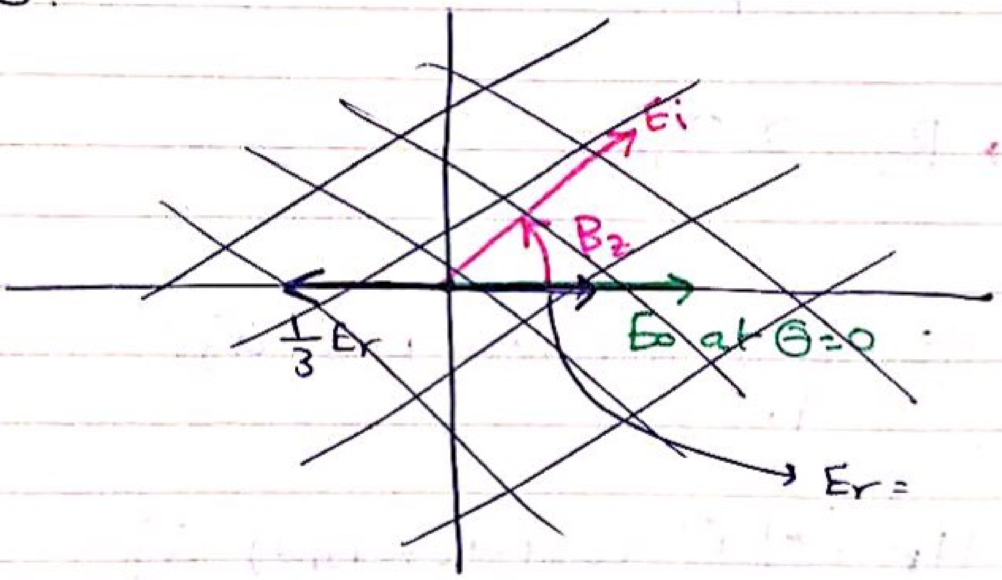
H → +ve y.

* 2 waves ماكانو متعاطين.

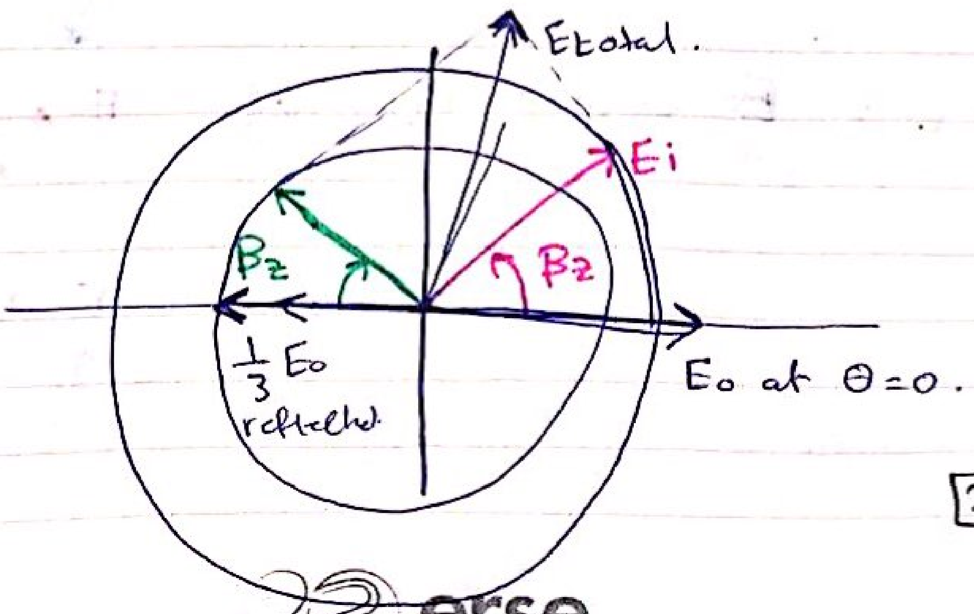


$\frac{2}{3}E_0$ ($E_i + E_r$
-Z
0

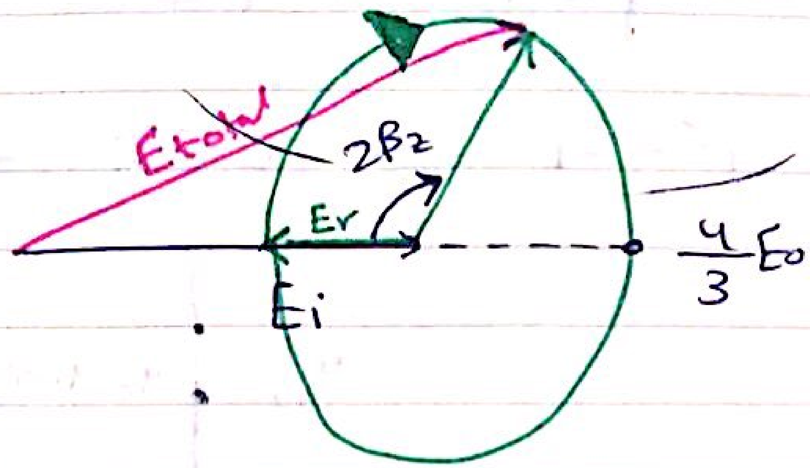
at t=0.



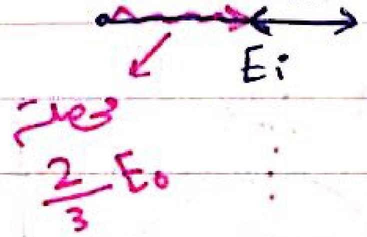
Ei
Bz
$\frac{1}{3}$Er
E0 at Θ=0
Er =



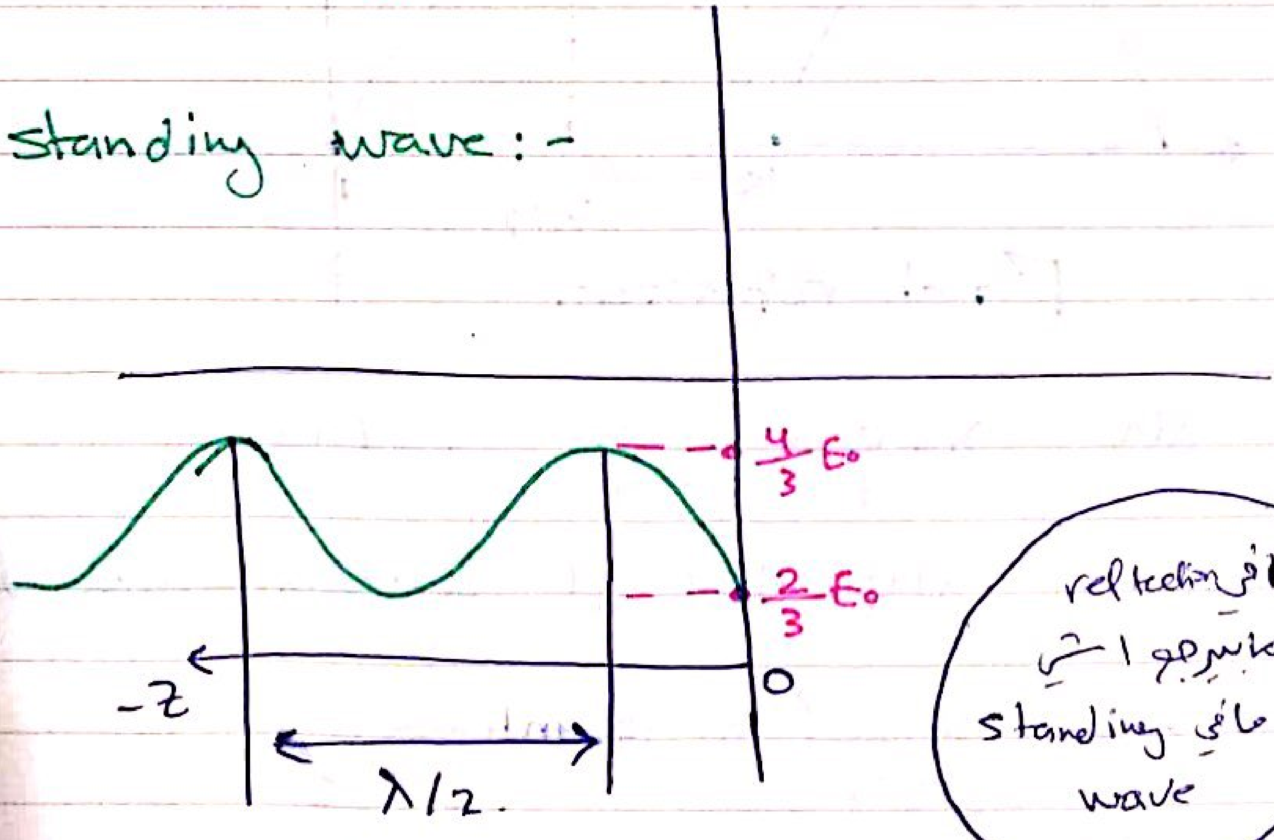
Etotal.
Ei
Bz
Bz
$\frac{1}{3}$E0
reflected
E0 at Θ=0.



at $\theta = 0$. $z = 1, \ldots$



standing wave :-



ما في reflection
ما برجعوا اشي
ما في standing wave

every λ/2 we see 2 peaks.

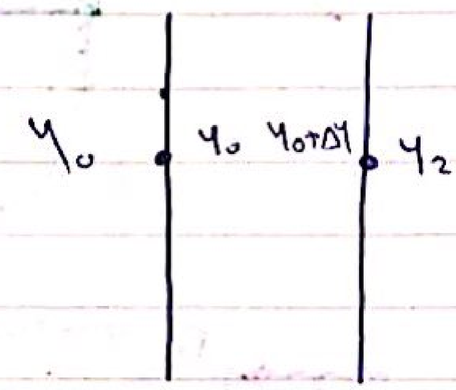
ضعف المرعش.

Γ -ve → min
Γ +ve → max.

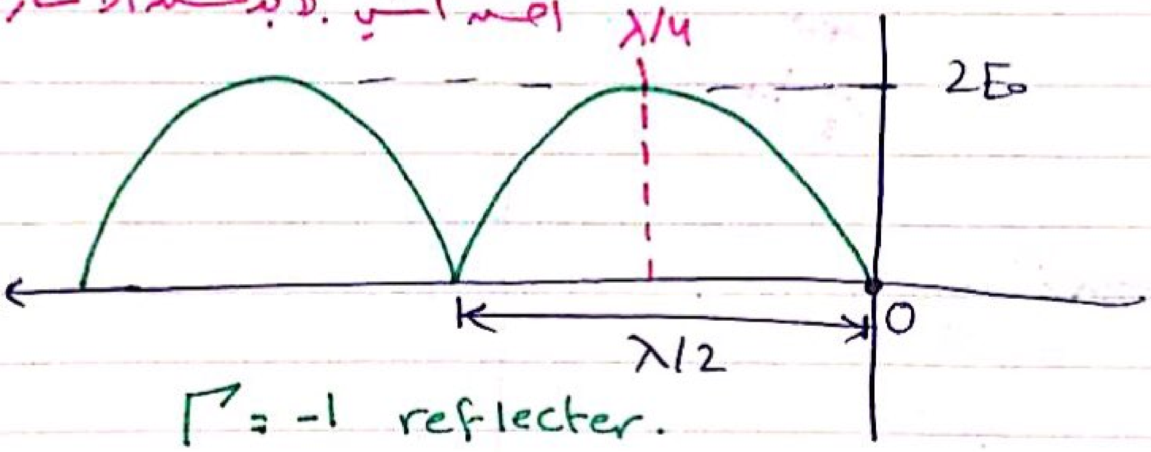
/ /

max power → match the 2 media.

$\Gamma = -1 \Rightarrow \tau = 0$ → no reflection.



(اهم اشي . لا بتحسد الاشارة)



$\Gamma = -1$ reflecter.

AM $\lambda = \frac{c}{f} = \frac{3\times10^8}{801\,KHz} = 374$ m.

$\lambda/4 = 93$ m (antenna. ارتفاع)

effect channel (TX, RX) ⇒ in antenna.

SAR ≡ Specific apsortion ~~Rate~~ Radio.

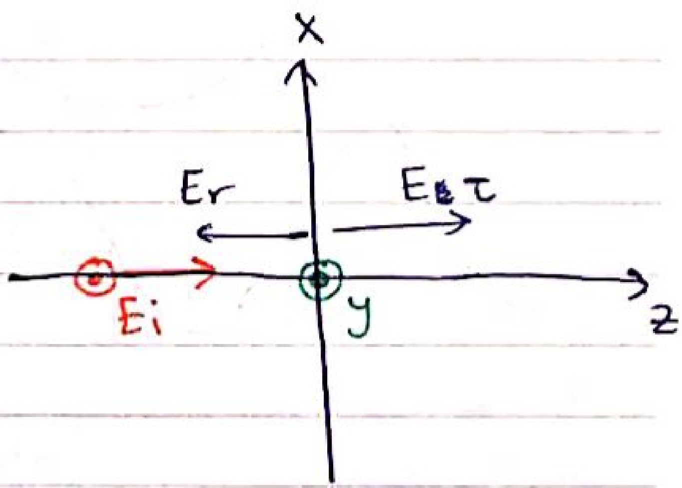
31/7/ MON

Ex

$\eta_1 = \eta_0$

$\eta_2 = 200 - j100$

$E_i = 5\cos(\omega t - \beta_1 z)\,\vec{a_y}$



$$\Gamma = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1}$$

$$= \frac{200 - j100 - 377}{200 - j100 + 377}$$

$$= \frac{-177 - j100}{577 - j100}$$

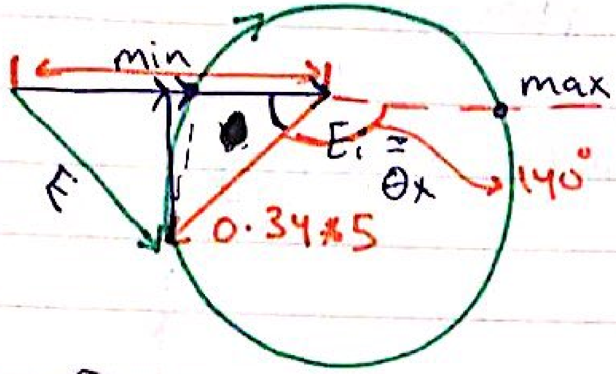
$$= 0.34\angle -140^\circ$$

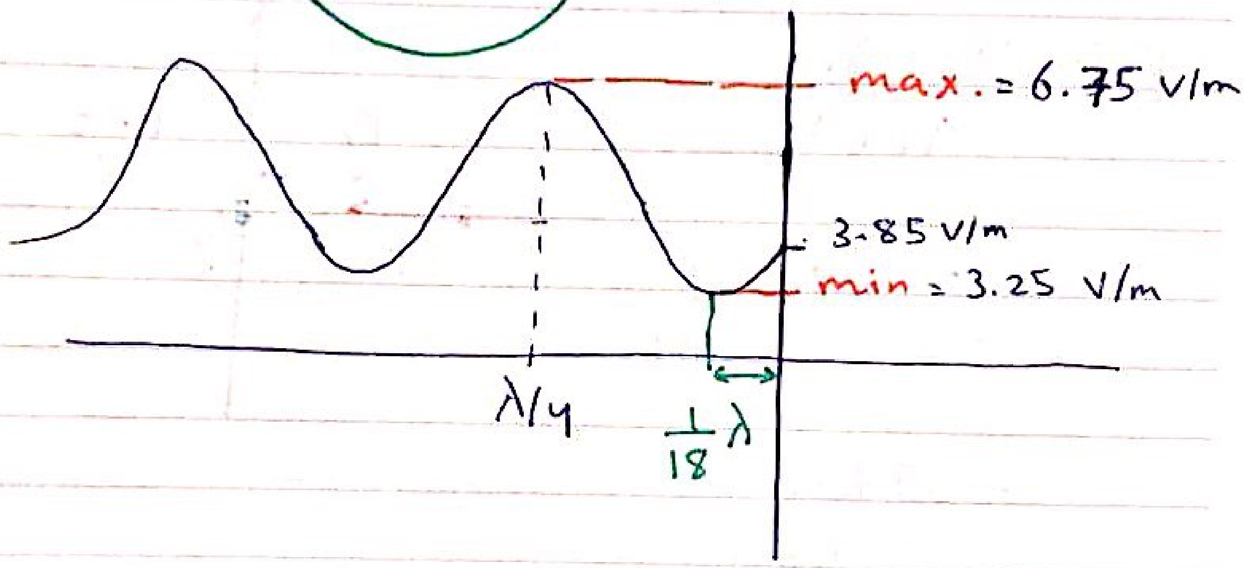
$$\tau = 1 + \Gamma$$

$$= 0.76\angle -16.7^\circ$$

$$E_r = 0.34 * 5\cos(\omega t + \beta_1 z + 140^\circ)\,\vec{a_y}$$

$$E_\tau = 0.76 * 5\cos(\omega t - \beta_2 z + 16.7^\circ)\,\vec{a_y}$$





⇒ $\Gamma E_0 \sin(\theta_r)$

min = $E_0(1-\Gamma)$

max = $E_0(1+\Gamma)$

→ $E_0 + \Gamma E_0 \cos(\theta_r$.

$$E = E_0\sqrt{(\Gamma \sin(\theta_r))^2 + (1+\Gamma\cos(\theta_r))^2}$$

$$E = E_0\sqrt{(\Gamma \sin(\theta_x))^2 + (1+\Gamma\cos(\theta_r))^2}$$

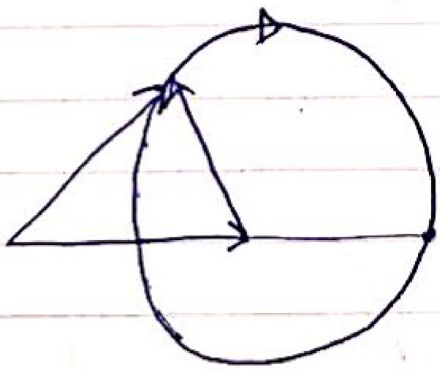
• $180 - \theta_x = 40$

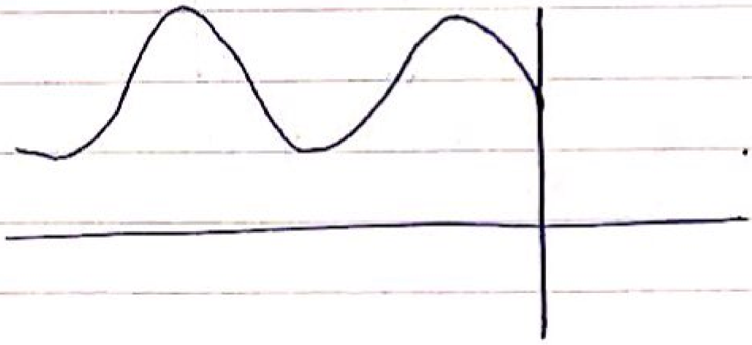
$$\frac{40}{360} * \frac{\lambda}{2} = \frac{1}{18\lambda}$$

$$E = E_o \sqrt{(\Gamma \sin(-140))^2 + (1 + \Gamma \cos(-140))^2}$$

$= 3.85$ V/m.

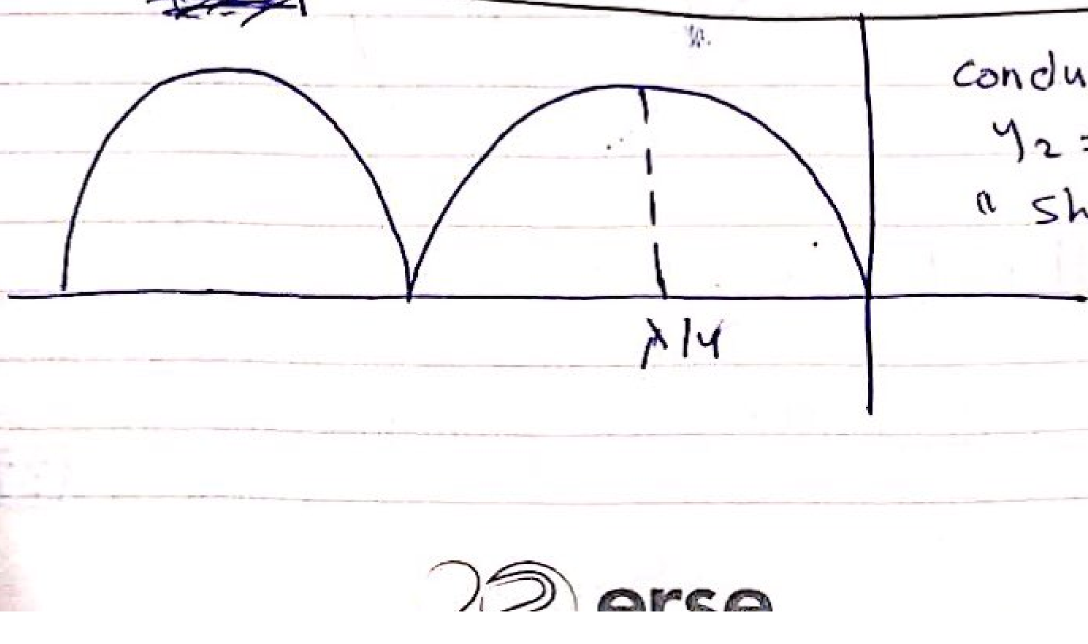
if Γ +ve.



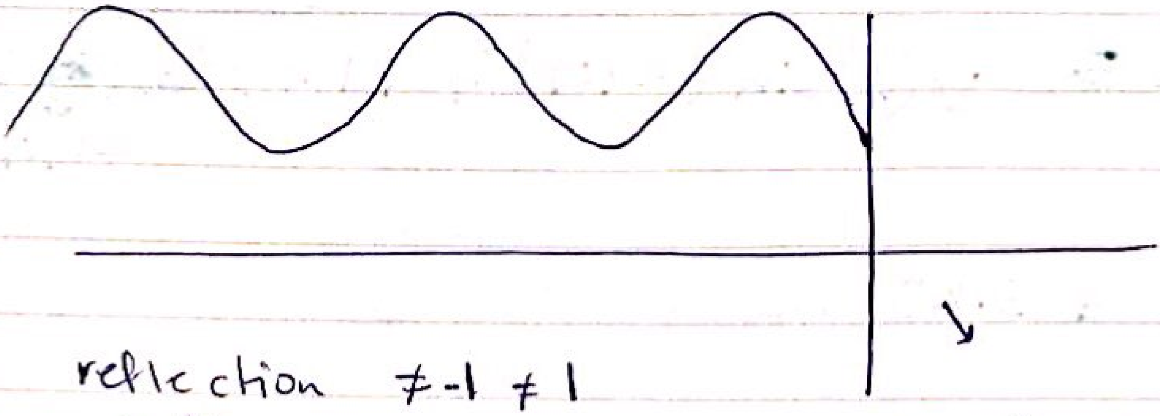


بيلش من
عند ال max.

if perfect conductor.
$\Gamma = -1$, $\eta_2 = 0$, $\tau = 0$

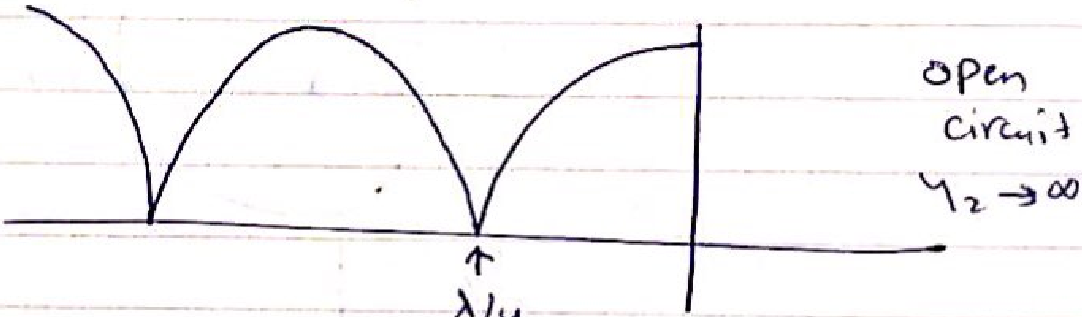


conductor
$\eta_2 = 0$
(a short cck)

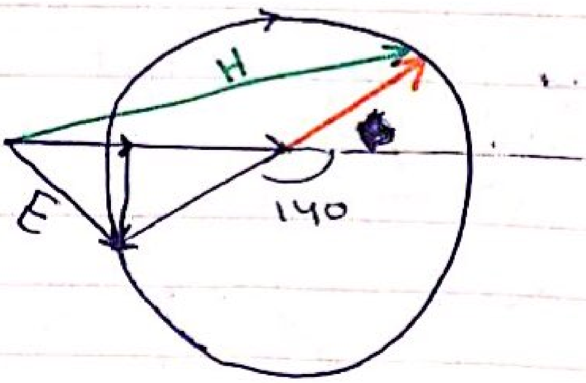


reflection coefficent. ≠ -1 ≠ 1

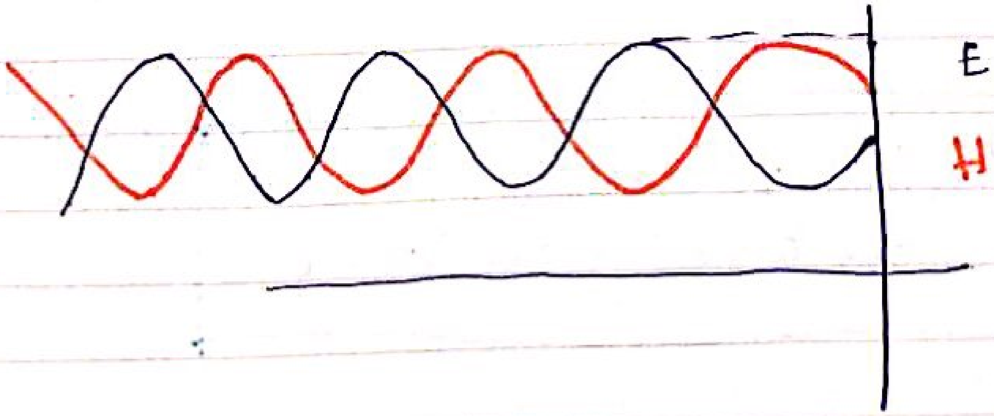
perfect طوق سي conductor.



nulse E = 0.



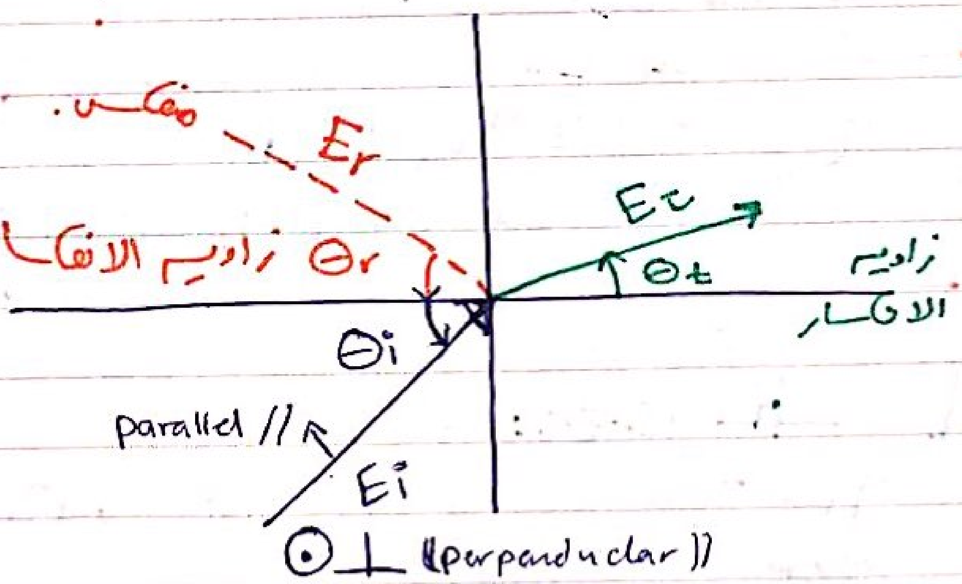
H ⊥ E in space.



H reflection E.

stand wave H عكس stand wave E

* Oblique Incedence :



$$n_1 \sin\theta_i = n_2 \sin\theta_t$$

$$n = \sqrt{\mu_r \varepsilon_r}$$

⊥ :

y باتجاه direction

$$\Gamma_\perp = \frac{\eta_2 \cos\theta_i - \eta_1 \cos\theta_t}{\eta_2 \cos\theta_i + \eta_1 \cos\theta_t}$$

$$\tau_{\perp} = \frac{2\eta_2 \cos\theta_i}{\eta_2 \cos\theta_i + \eta_1 \cos\theta_t}$$

// 8 -

$$\Gamma_{//} = \frac{\eta_2 \cos\theta_t - \eta_1 \cos\theta_i}{\eta_2 \cos\theta_t + \eta_1 \cos\theta_i}$$

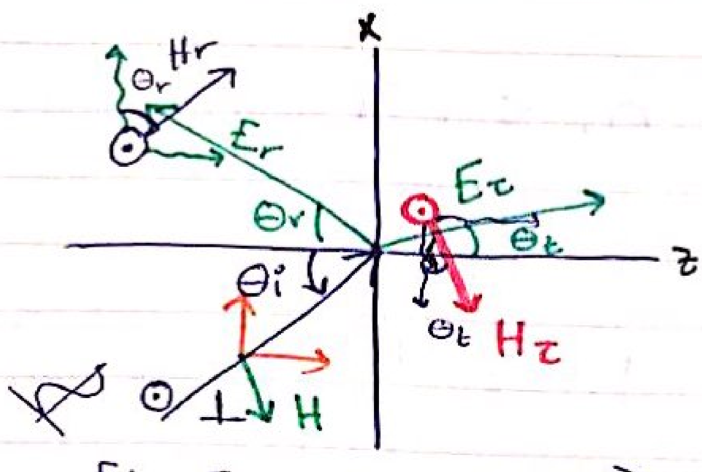
تأكد من كتاب

$$\tau_{//} = \frac{2\eta_2 \cos\theta_i}{\eta_2 \cos\theta_t + \eta_1 \cos\theta_i}$$

Ex — $\perp$ Case: —

$\eta_1 = 200$, $\eta_2 = 100$, $\theta_i = 30$

$\Gamma_{\perp} = ?!$



$E_i = E_0 \cos(\omega t - \beta r)\, \vec{a_y}$

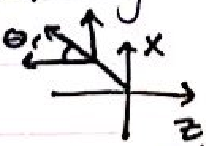
ما تكتب متغير داخل اتجاه ال propagation

$$\frac{2\pi}{\lambda}\left(\cos(\theta_i)\, z + \sin\theta_i\, \underline{\underline{X}}\right) \quad = \beta = \frac{2\pi}{\lambda}$$

z ← باتجاه z axes

X ← اتجاه ال x axis.

$$E_i = E_0 \cos(\omega t - \beta_1(\cos(\theta_i) Z + \sin(\theta_i) X)\ \vec{a_y}$$



$$E_r = \Gamma_\perp E_0 \cos(\omega t - \beta_1(\underline{\underline{-\cos(\theta_r) Z}} + \sin(\theta_r) X)\ \vec{a_y}$$

$\varepsilon_{r1} = 3.55 \rightarrow \eta = \frac{\eta_0}{\sqrt{\varepsilon_r}} \Rightarrow \varepsilon_r = \left(\frac{\eta_0}{\eta}\right)^2 = \left(\frac{120\pi}{200}\right)^2 = 3.55$

$\varepsilon_{r2} = 14.2 \rightarrow \left(\frac{120\pi}{100}\right)^2 = 14.21$

$$\sqrt{\varepsilon_{r1}}\sin(30) = \sqrt{\varepsilon_{r2}}\sin(\theta_t)$$

$$\sin\theta_t = \sqrt{\frac{3.55}{14.2}}\ \sin 30.$$

$$\boxed{\theta_t = 14.4^\circ}$$

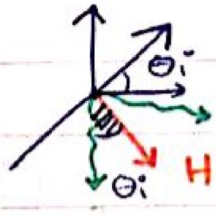
$\Gamma_\perp =$ ~~[illegible]~~ -0.38

$\tau = 0.62$

$\tau = 1 + \Gamma$ in $\perp$ correct.

$\tau \neq 1 + \Gamma$ in //

$$E_\tau = \tau E_0 \cos\left(\omega t - \sqrt{\frac{\varepsilon_{r2}}{\varepsilon_{r1}}}\,\beta_1 (\cos\theta_t Z + \sin\theta_t X)\right) \vec{a_y}$$



$\odot$ $E \to y$ اتجاه

$$H_i = \frac{E_0}{\eta_1} \cos(\omega t - \beta_1 (\cos\theta_i Z + \sin\theta X)) * (-\cos\theta_i \vec{a_x} + \sin\theta_i \vec{a_z})$$

$$H_r = \frac{\Gamma_\perp E_0}{\eta_1} \cos(\omega t - \beta_1 (-\cos\theta_i Z + \sin\theta X)) * (\cos\theta_r \vec{a_x} + \sin\theta_r \vec{a_z})$$

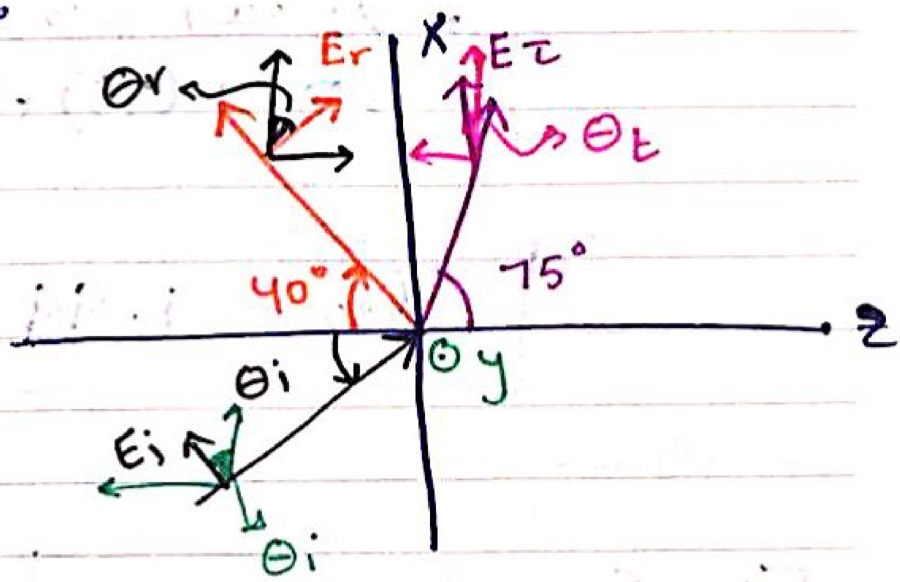
$$H_\tau = \frac{\tau E_0}{\eta_2} \cos(\omega t - \beta_2 (\cos\theta_i Z + \sin\theta X)) * (-\cos\theta_t \vec{a_x} + \sin\theta_t \vec{a_z}).$$

Ex $\eta_1 = 200 \rightsquigarrow \varepsilon_{r1} = 3.5$

$\eta_2 = 300 \rightsquigarrow \varepsilon_{r2} = 1.579$

$f = 2.4\,GHZ$ (freq for wireless)

$\theta_i = 40°$



$$\eta = \eta_0 \sqrt{\frac{\mu_r}{\varepsilon_r}}$$

$$\varepsilon_{r1} = \left(\frac{\eta_0}{\eta_1}\right)^2$$

$$\boxed{\varepsilon_{r1} = 3.55}$$

$$\sqrt{\varepsilon_{r1}} \sin\theta_i = \sqrt{\varepsilon_{r2}} \sin\theta_t$$

$$\sin\theta_t = \sqrt{\frac{\varepsilon_{r1}}{\varepsilon_{r2}}} \sin\theta_i$$

$$\boxed{\theta_t = 75°}$$

$$\Gamma_{\parallel} = \frac{\overset{300}{\eta_2} \cos(75) - 200 \cos(40)}{300 \cos(75) + 200 \cos(40)}$$

$$\boxed{\Gamma_{\parallel} = -0.327}$$

$$\tau_{\parallel} = \frac{2\eta_2 \cos\theta_i}{\eta_2 \cos\theta_t + \eta_1 \cos\theta_i}$$

$$= \frac{2(300)\cos(40)}{300\cos(75) + 200\cos(40)}$$

$$\boxed{\tau_{\parallel} = 1.99}$$

* $E_i = E_o \cos\left(\omega t - \frac{2\pi * 100}{6.6}\left(\cos\theta_i\, z + \sin\theta_i\, x\right)\right)$

* $\left(\cos\theta_i\, \vec{a_x} - \sin\theta_i\, \vec{a_z}\right)$

$$B_1 = \frac{2\pi}{\lambda_1}$$

$\lambda_1 = ?!$

$u_1 = \frac{c}{\sqrt{\varepsilon_{r_1} \mu_{r_1}}}$ if $\mu_{r_1} = 1$

$u_1 = \frac{c}{\sqrt{\varepsilon_{r_1}}} \Rightarrow \lambda = \frac{u}{f} = \frac{c}{\sqrt{\varepsilon_{r_1}}} \cdot \frac{1}{f}$

$$\lambda_1 = \frac{3\times10^8}{\sqrt{3.55}} \cdot \frac{1}{2.4\times10^9} = 6.6\text{ cm}.$$

$$\lambda_2 = \frac{3\times10^8}{\sqrt{1.57}} \cdot \frac{1}{2.4\times10^9} = 9.9\text{ cm}.$$

* $E_r = ?!$ $\rightsquigarrow$ $E_r = \Gamma E_{oi}$

$$E_r = -E_o * 0.32 \cos\left(\omega t - \frac{2\pi*100}{6.6}\left(-\cos\theta_r z + \sin\theta_r x\right)\right)$$
$$*\left(\cos\theta_r \vec{a_x} + \sin\theta \vec{a_z}\right)$$

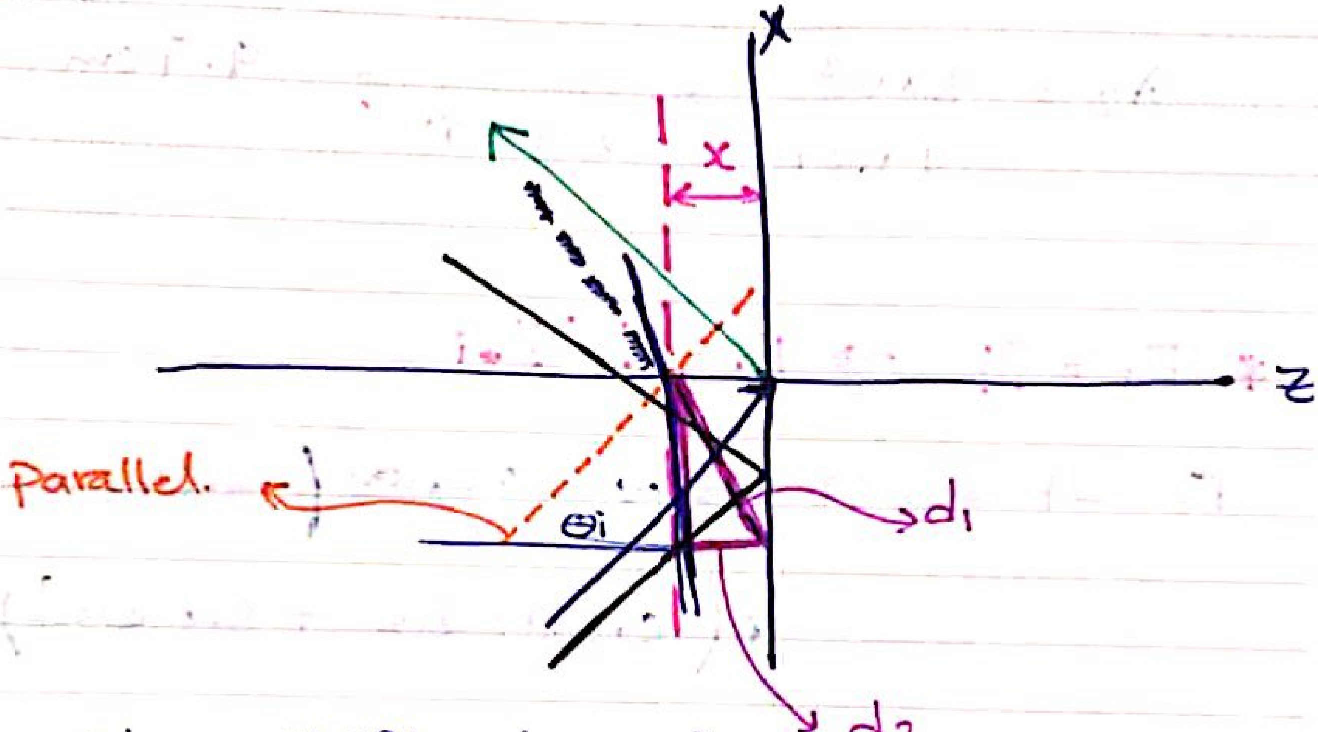
* $E_\tau = \tau E_i$

$$E_\tau = 1.99\, E_o \cos\left(\omega t - \frac{2\pi*100}{9.9}\left(\cos\theta_t z + \sin\theta_t x\right)\right)$$
$$*\left(\cos\theta_t \vec{a_x} - \sin\theta_t \vec{a_z}\right)$$

$\Rightarrow H_i = \frac{E_o}{\eta_1} \cos(\ \_\_\_\_\ )\ \vec{a_y}$

$\Rightarrow H_r = \frac{E_o * 0.32}{\eta_1} \cos(\ \_\_\_\_\ )\ \vec{a_y}$

$$\Rightarrow H_r = \frac{1.99\,E_o}{\eta_2} \cos(\quad \_\_\_ \quad)\, \vec{a_y}$$

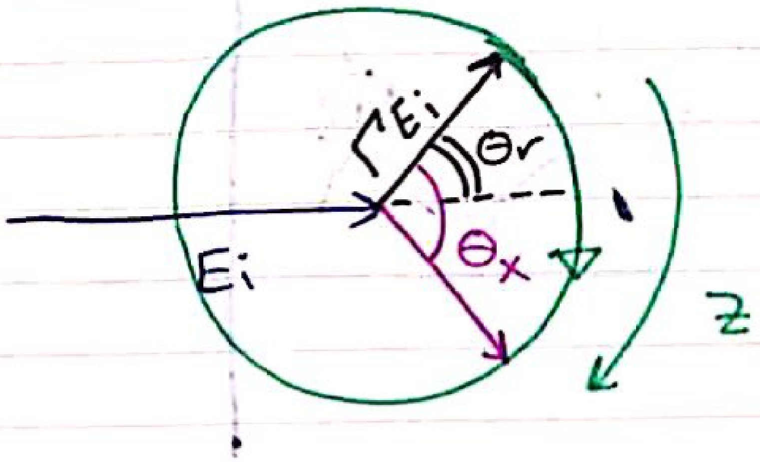


Phas shift btw i, r

$$d_1 = \frac{z}{\cos\theta_i}$$

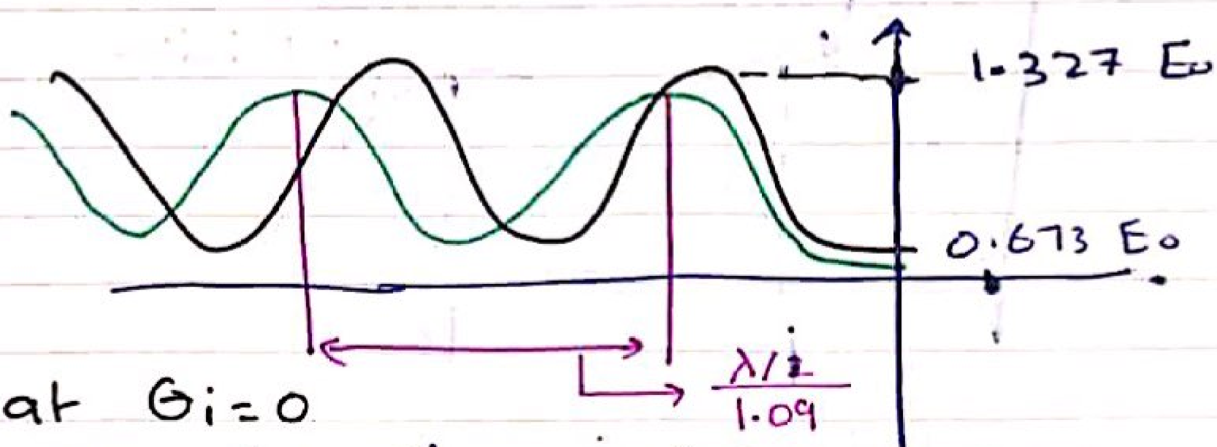
$$d_2 = d_1 - 2\sin^2\theta_i$$

$$d_2 = \frac{z}{\cos\theta_i} - z\sin^2\theta_i$$



$$\theta_x = (d_1 + d_2) * \frac{2\pi}{\lambda}$$

$$= z\left(\frac{2}{\cos\theta_i} - \frac{\sin^2\theta_i}{2}\right) * \frac{2\pi}{\lambda}$$



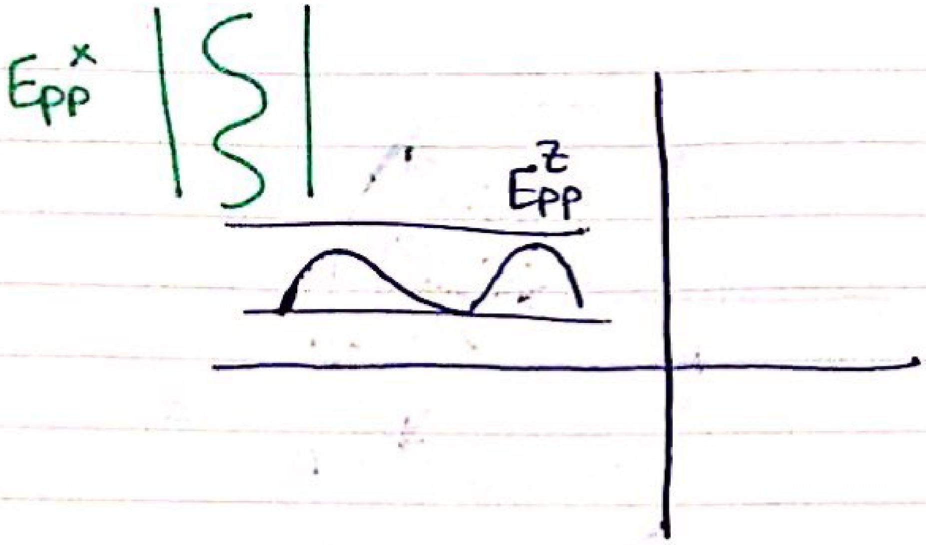
at $\theta_i = 0$

$E_o(1+\Gamma) = 0.673\, E_o$

$E_o(1-\Gamma) = 1.327$

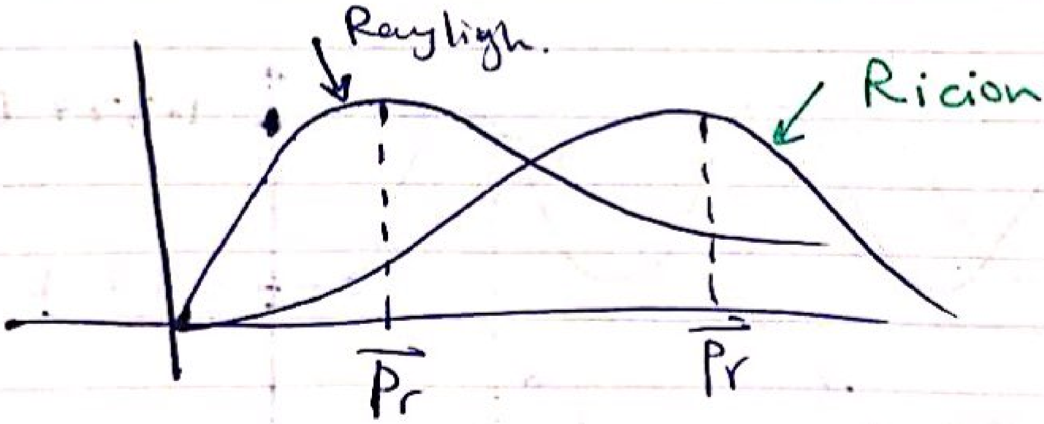
at $\theta_i = 40$

$$\left(\frac{1}{\cos\theta_i} - \frac{\sin^2\theta_i}{2}\right) = 1.098 \Rightarrow \text{expanded}$$



$$\theta_i = \tan^{-1}\left(\frac{Epp^x}{Epp^z}\right)$$

* تداخل الامواج مع نفسها ⇐ nulling.



reflected ☆ ← I

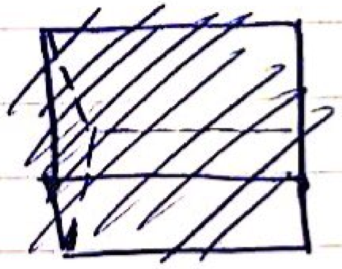
$$E_{r\,total}(space) = \sum_{i=1}^{I} |\Gamma_i|\, E_0\, e^{j\theta_i}$$

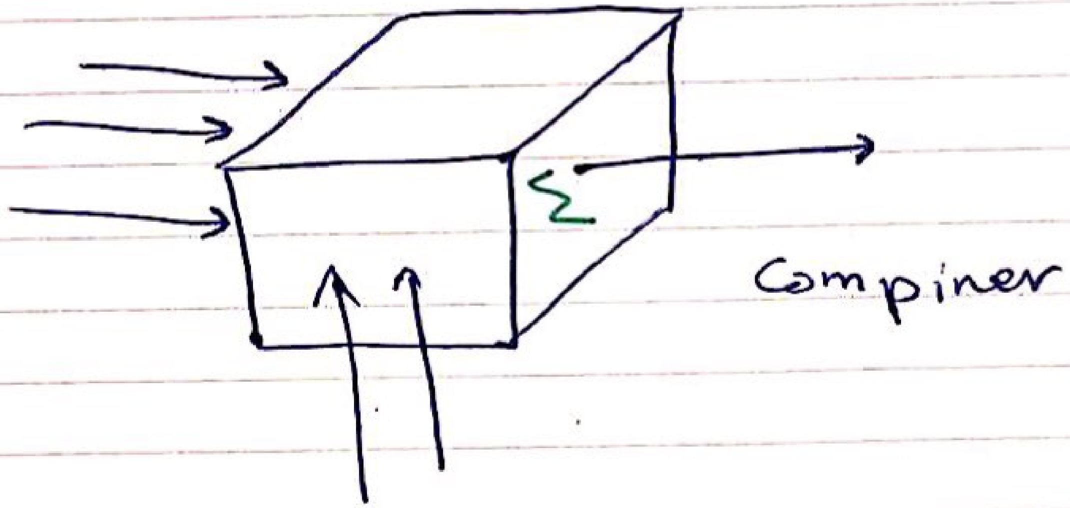
θ_i → delay

نفسها تمثل. $(\omega t - \beta r)$

$$H(z) = \sum |\Gamma_i| \, z^{-i}$$

↳ in Z transformer.





2/8/ Wed

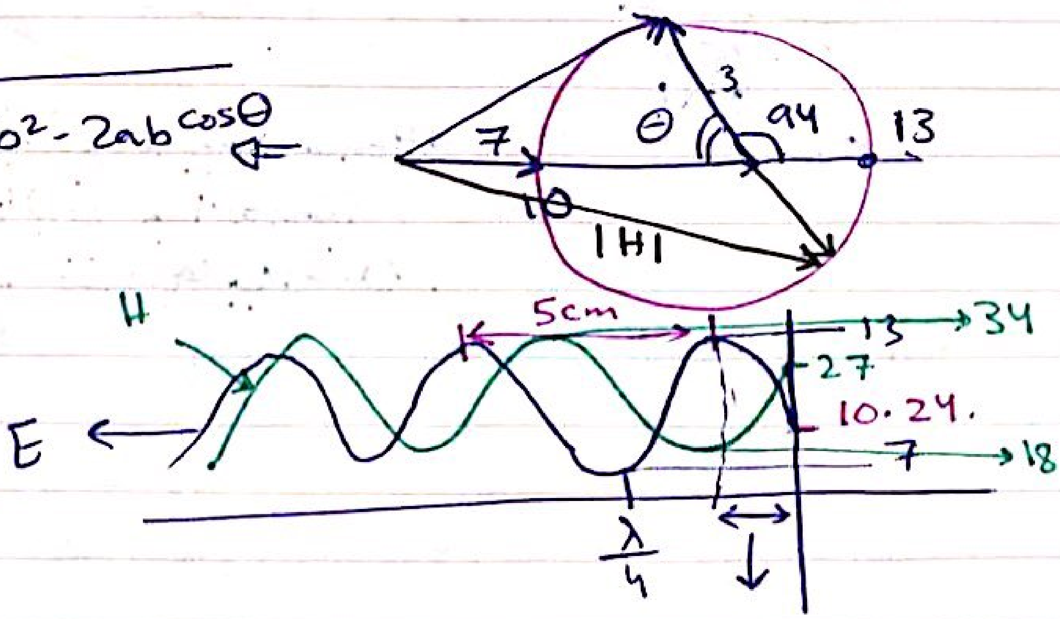
$$\tau_{\perp} = 1 + \Gamma_{\perp}$$

$$\tau_{\parallel} = (1 + \Gamma_{\parallel}) \frac{\cos\theta_i}{\cos\theta_t}$$

Quiz 2: for normal incedent from free space wave into $\eta_2 = 300 + j200$; Draw. the E & H standing waves
$E_i = 10\cos(\omega t - 20\pi z)\, \vec{a_y}$

Sol: $\Gamma_1 = \frac{300 + 200j - 377}{300 + 200j + 377} = 0.3\angle 94.6$

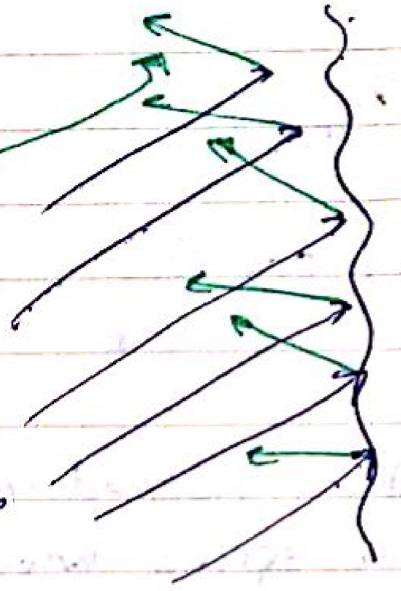
$\sqrt{a^2 + b^2 - 2ab\cos\theta}$



1.3 cm

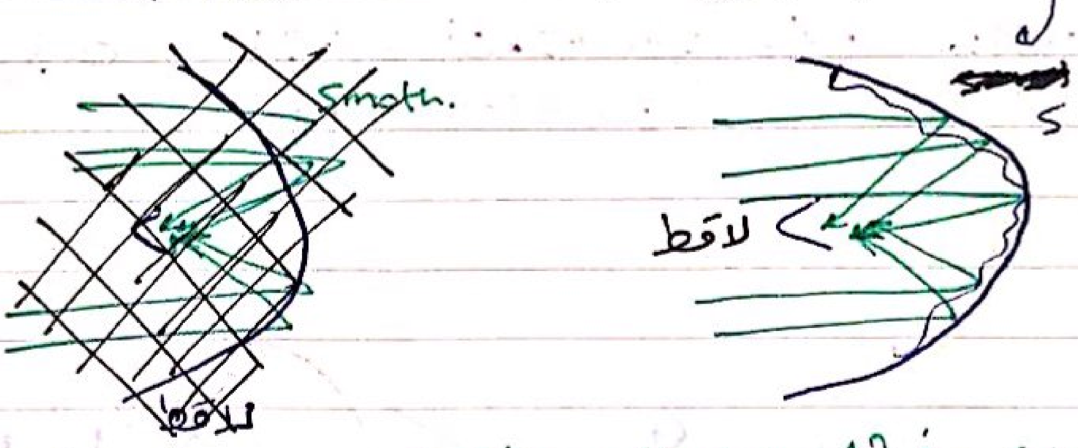
/ /

wave منعكسة
تظهر ركايف
random



مصدر واحد واتجاه واحد.
والمصدر بعيد
(far source) wave incident.

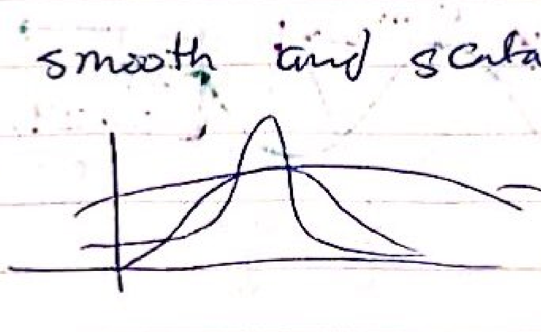
if far source → far field. → wave propagation مهم
if near " → near field.



smooth.

attenuation عادي في تابع ما بيصير scattering
بيصير تأثيرها
لكل نقطة بيلاشيك.

smooth and scattered.



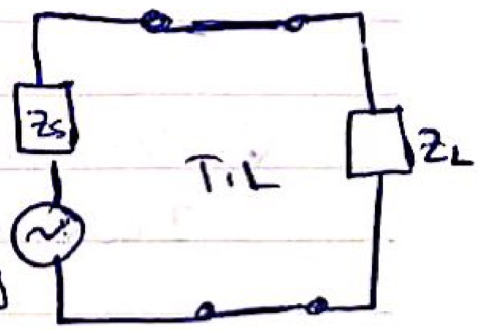
افضل الإشي smooth
بدي استقبل كل الـ signal

Transmission line :-

Signal track

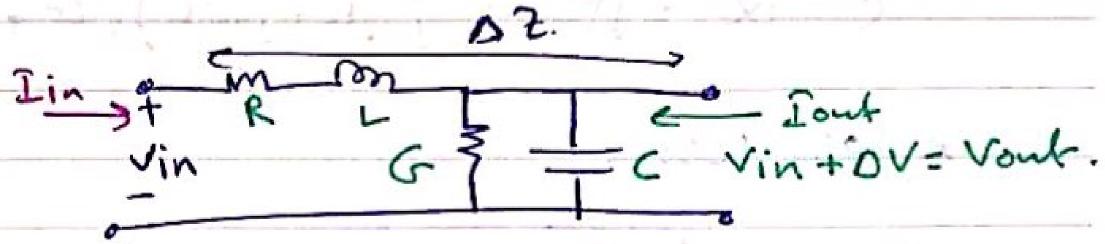
Vcc

ground



equivalent circuit بالشكل

all T.L we use lossless.
↳ 2conductor circuit.



2port network.

$$\frac{\partial V(z)}{\partial z} = (R + jwL)\, I(z).$$

$$\frac{-\partial I(z)}{\partial t} = (G + jwc)\, Vz$$

$$\nabla^2 V = \gamma^2 V$$

$$\nabla^2 I = \gamma^2 I$$

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

ده يعني الآتي ، لانو ال V بين 2conductor .

$$I = I_o \cos(\omega t - \beta z).$$

$$\frac{V_o}{I_o} = Z_{T.L}$$

$$\gamma = \alpha + j\beta = \sqrt{(R + j\omega L)(G + j\omega C)}$$

* loss less :

$$\beta = \omega\sqrt{LC}$$

L = H/m

C = F/m.

$$u = \frac{1}{\sqrt{LC}}$$ speed < c (سرعة الضوء)

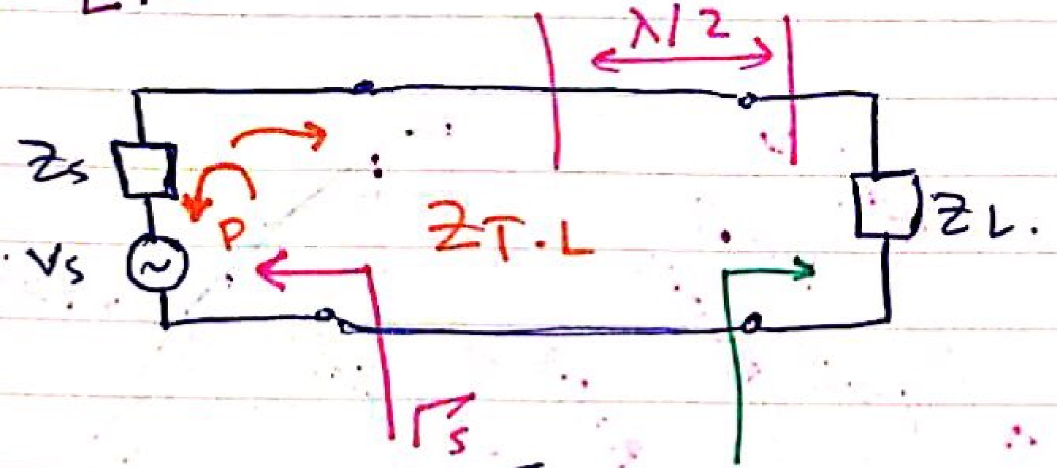
LC → parameter.

$$Z_{T.L} = \sqrt{\frac{L}{C}}$$

Mid (13/8) SUNDAY

3/8/ Thu

T.L :-



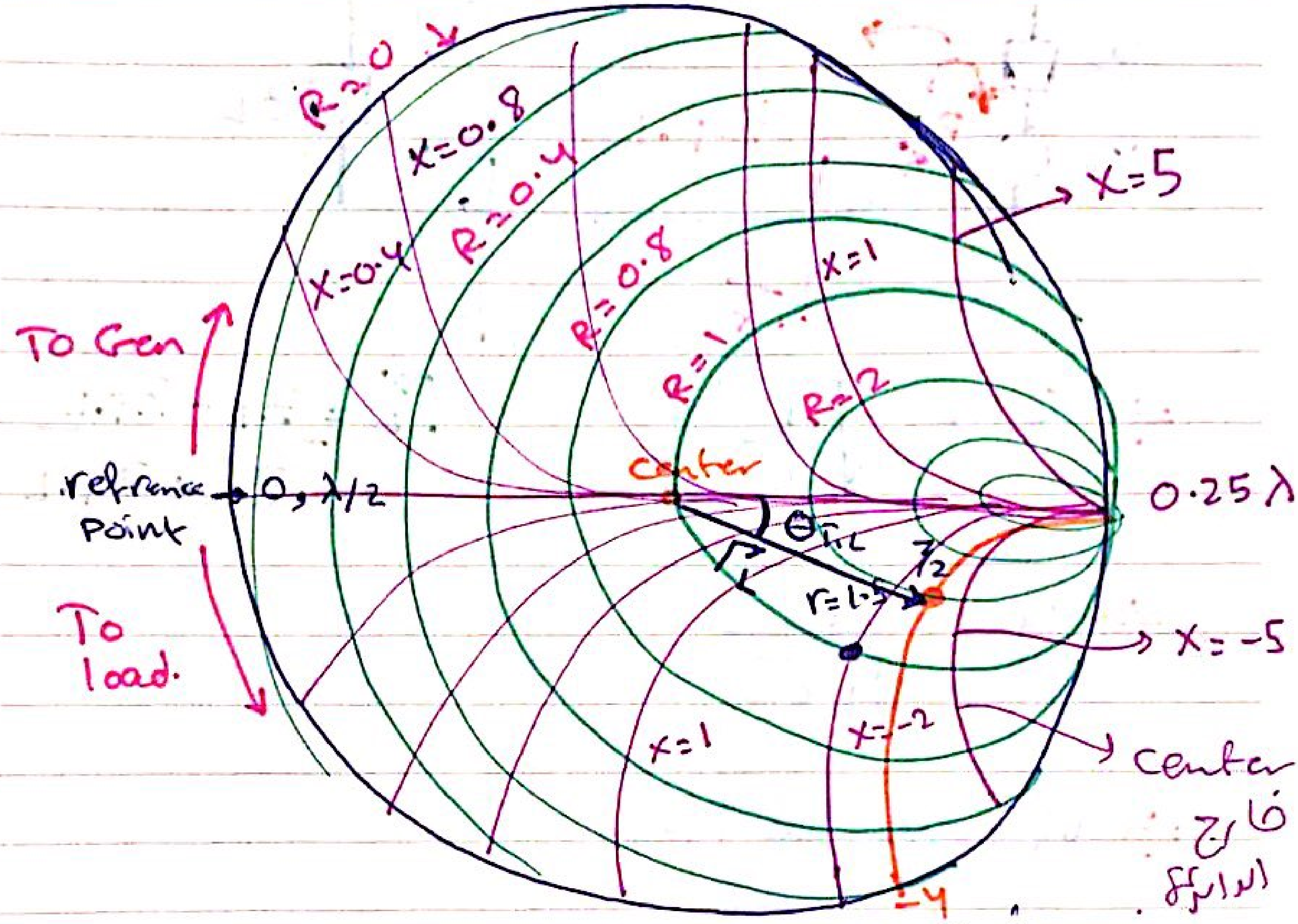
⇒ $Z_{T.L} = \sqrt{\frac{L}{C}}$

$\Gamma_L = \frac{Z_L - Z_{T.L}}{Z_L + Z_{T.L}}$

⇒ $u = \frac{1}{\sqrt{LC}}$

⇒ $V_s = V_o \cos(\omega t)$

* $\Gamma_s = \frac{Z_s - Z_{T.L}}{Z_s + Z_{T.L}}$



real part = 0. → في اكبر دائرة

Z = R + j X.

دوائر كاملة خضراء — R

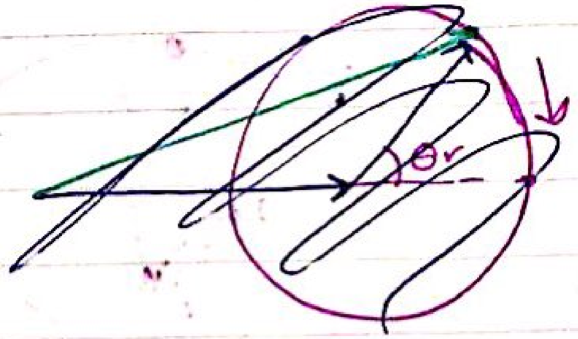
دوائر ناقصة — X

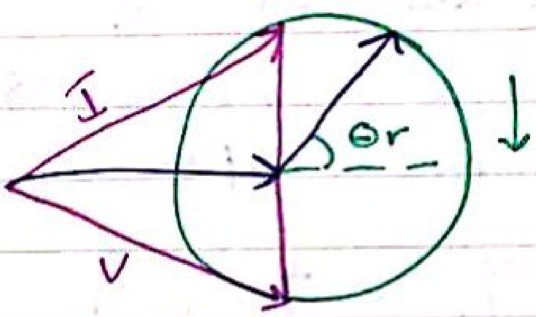
3 = 1.5 − j2

Z = $Z_{T.L}(1.5 - j2)$

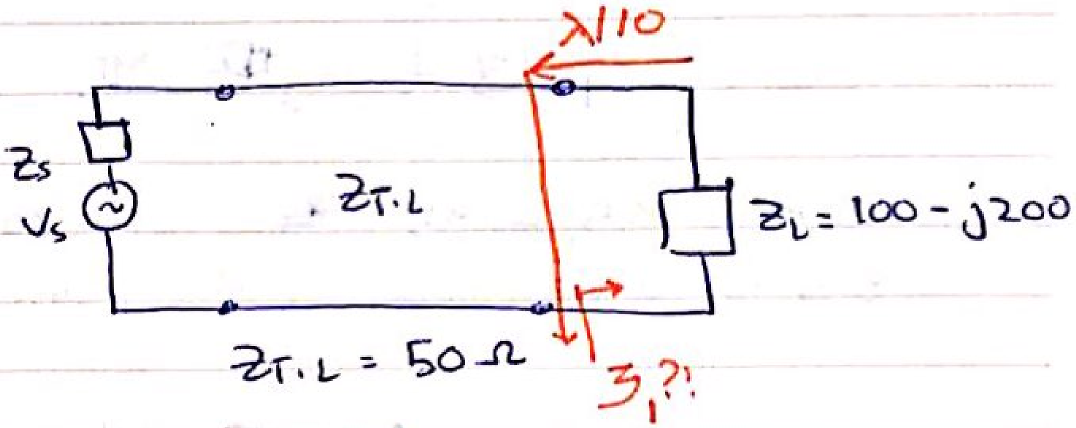
at center R = 1 , X = 0.

matching point center of T.L.





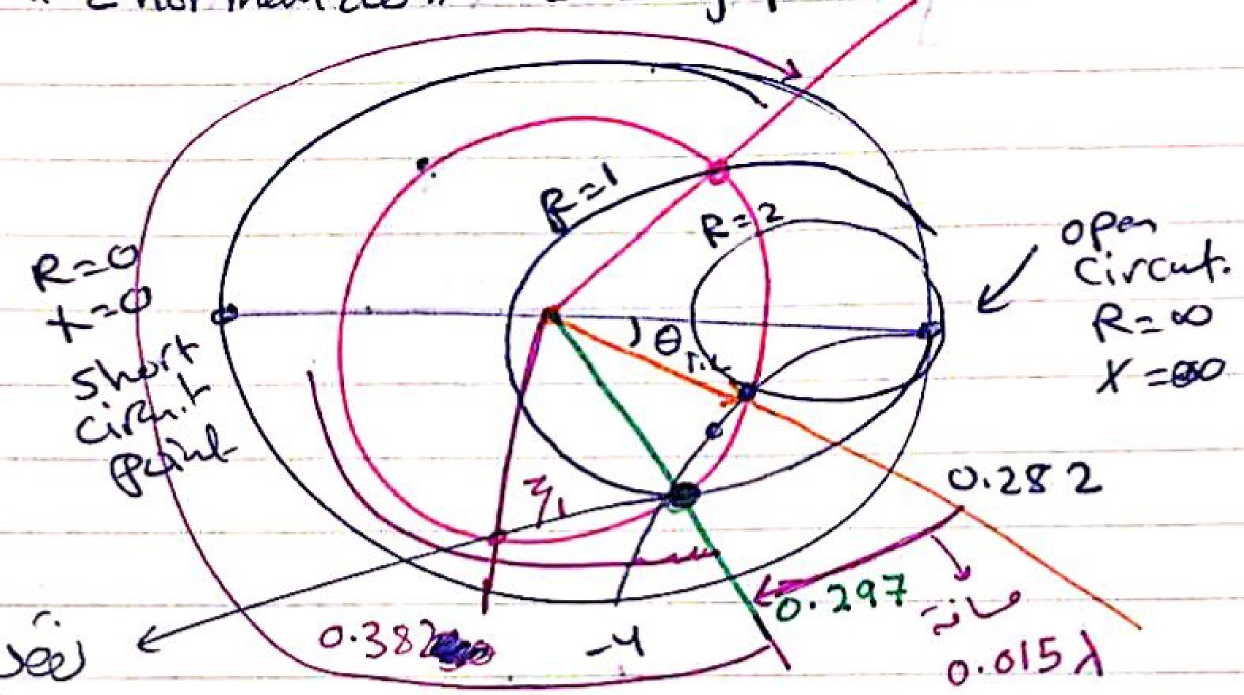
Ex1



*

T.L charging and discharging L, C

z ((Z normalized)) $= 2 - j4$



نقطة تقاطع دائرة مع R=1
$z_2 = 1 - j3$

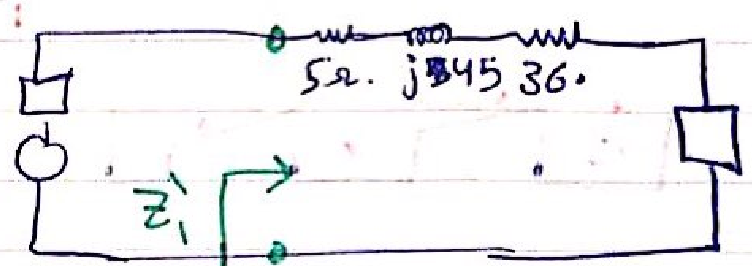
كنت عند 0.282 بدي ازيد λ/10 ←

$0.282 + \lambda/10 =$

$z_1 = 0.17 - j0.9$

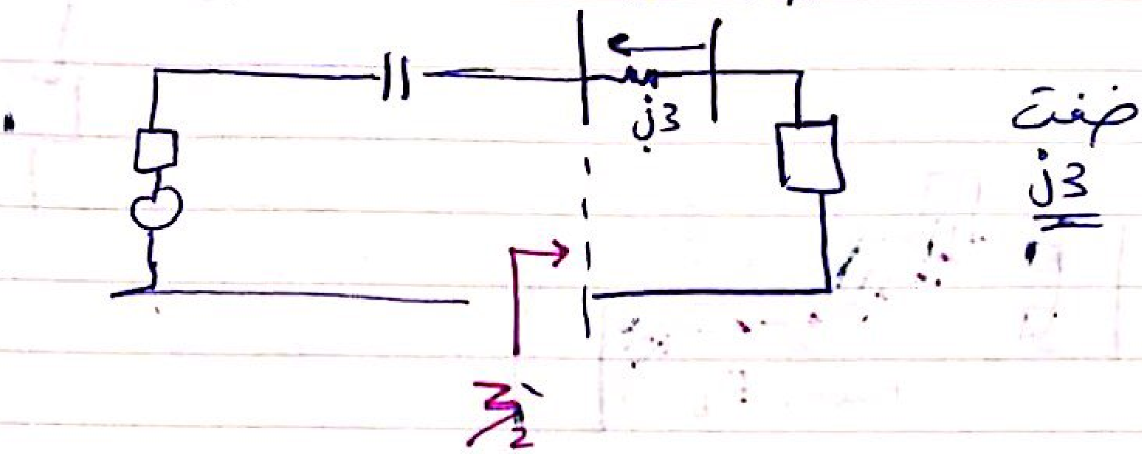
$Z_1 = 8.5 - j45$

$Z_i = 45 - j45$ بدي اضل ال
ضيف مقاومة قيمتها الفرق بين 45 و 8.5.



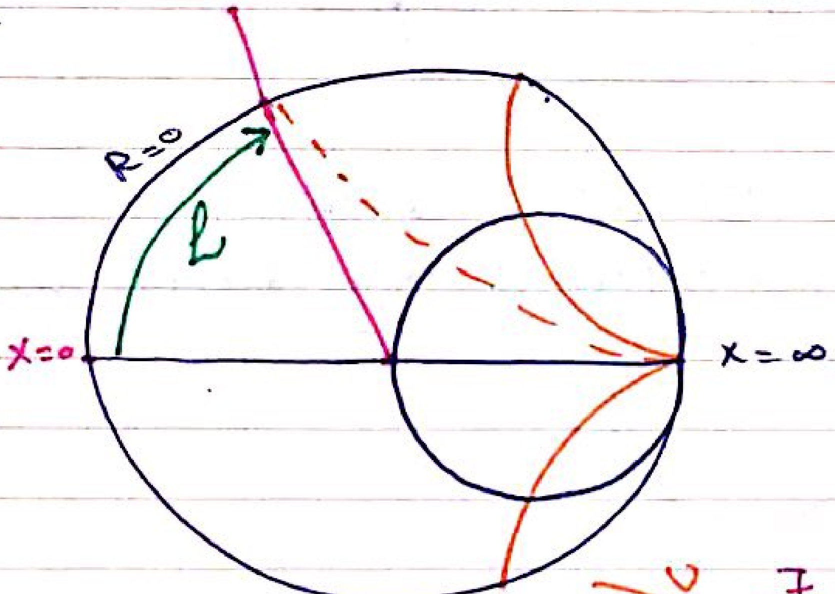
بدي اضل $0 = j45$ ← كمان Inductor.
بعدين بدي اضل قيمة $Z_1=50$ ضيف مقاومة كمان.

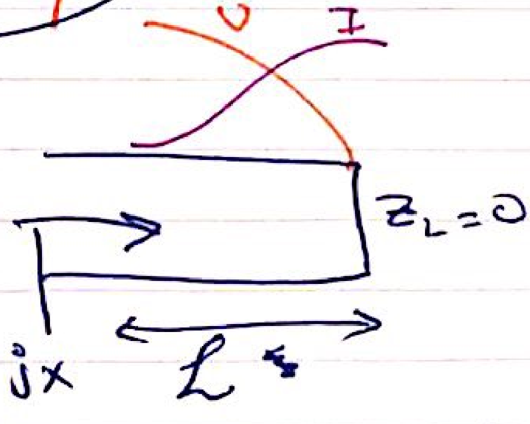
$Z_1' = 50\Omega$



$Z_2' = 1 \rightarrow Z = 50\,\Omega$.

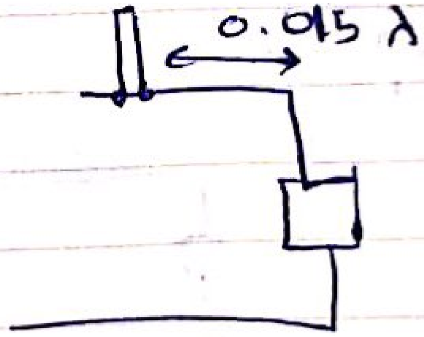
Stub:

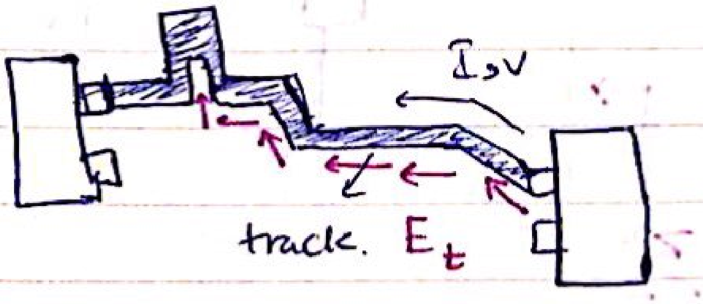




$jx = j3$

$\ell = 0.198\lambda$

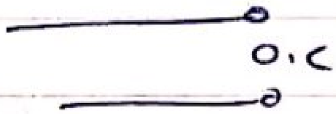




$$\vec{J} = \sigma \vec{E}$$

$$\varepsilon \vec{E}$$

DC path. اذا مابدي.



فرق بين O.C و S.C ← λ/4.

Ex

$Z_L = 100 + j75$

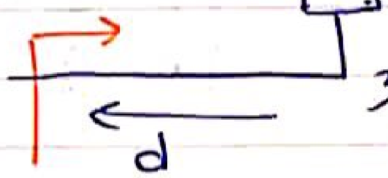
$Z_{T.L} = 50\,\Omega$

$\lambda = 5cm$

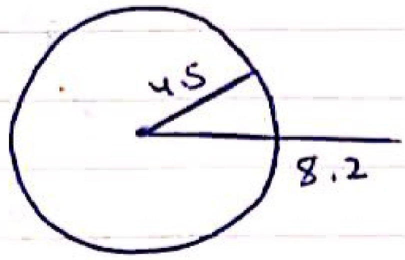
Find Z at 6.15 cm from load ?!

sol:

$6.15 = 1.23\,\lambda$



$\frac{4.5}{8.2} = 0.54 \angle 30$

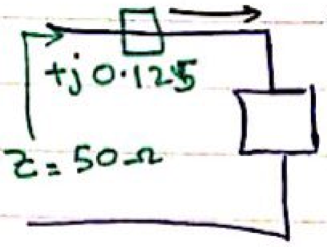


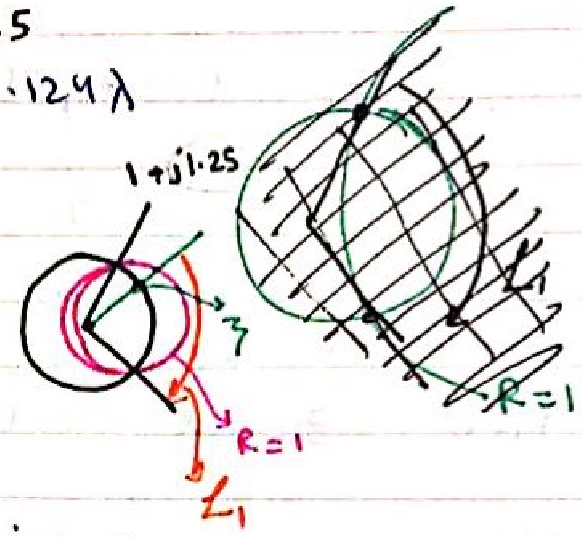
$Z_1 = 50 * (0.35 - j0.38)$

$Z_1 = 17.5 - j19$

$z_2 = 1 - j1.25$

$l_1 = 0.124\lambda$





Case 1:

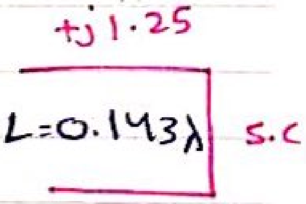
* Series Matching :

- Inductive :

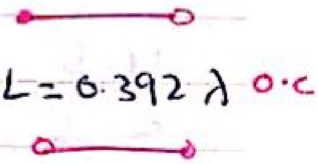
$l_1 = 0.124\lambda$

$(jX = j1.25)$

⇒ ①



②

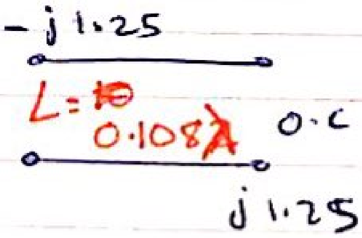


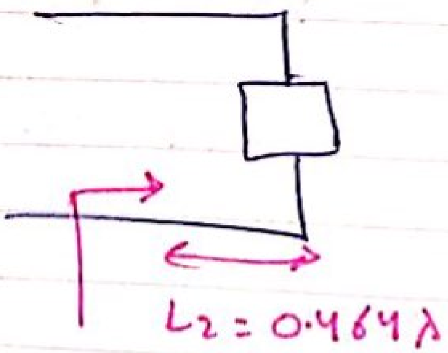
- Capacitive :

$l_2 = 0.464\lambda$

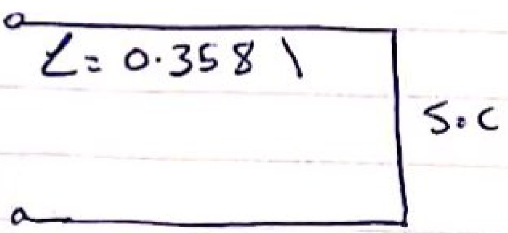
$jX = -j1.25$

①

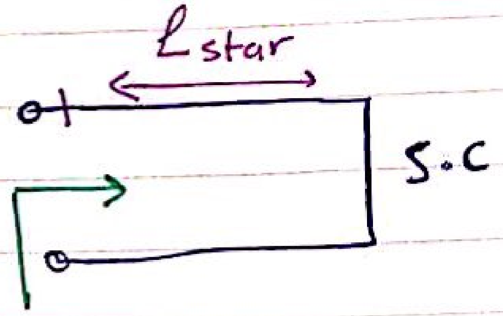




②

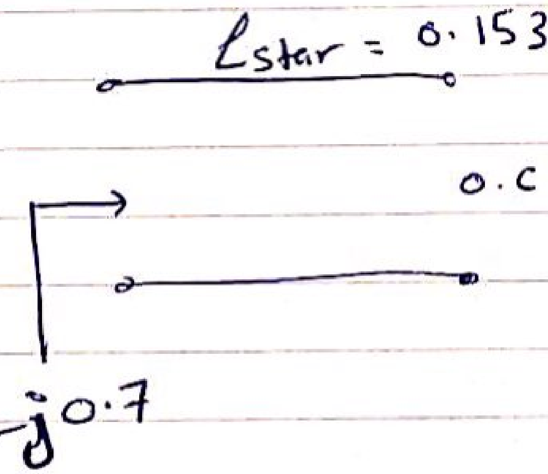


Ex



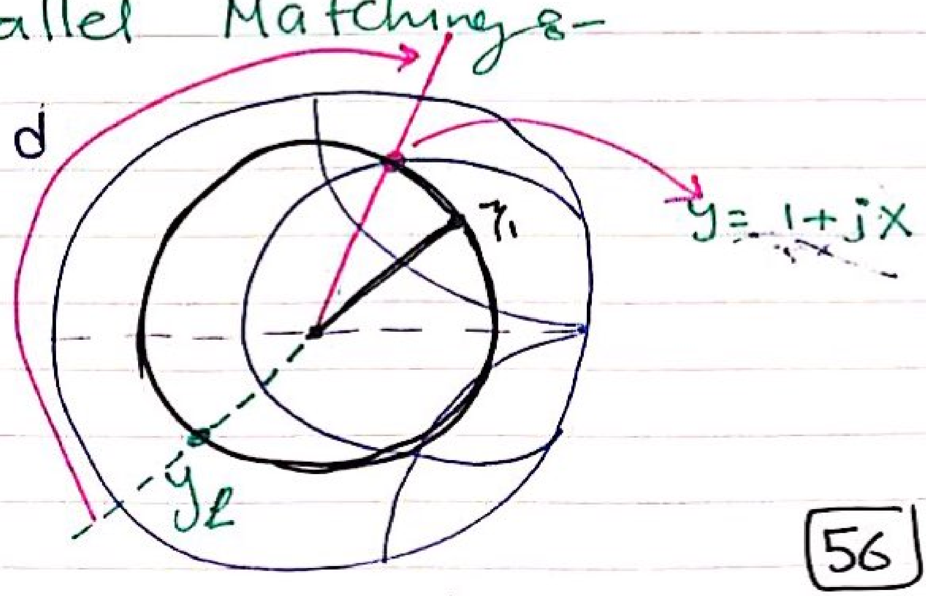
$-j0.7$ ((series capacitor → معتمد ع freq))

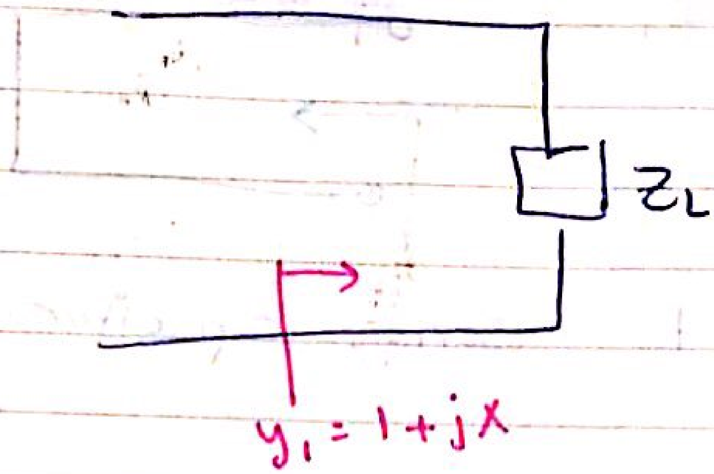
ℓ_{star} = ~~0.403 λ~~ 0.403 λ



Case 2:-

* Parallel Matching:-



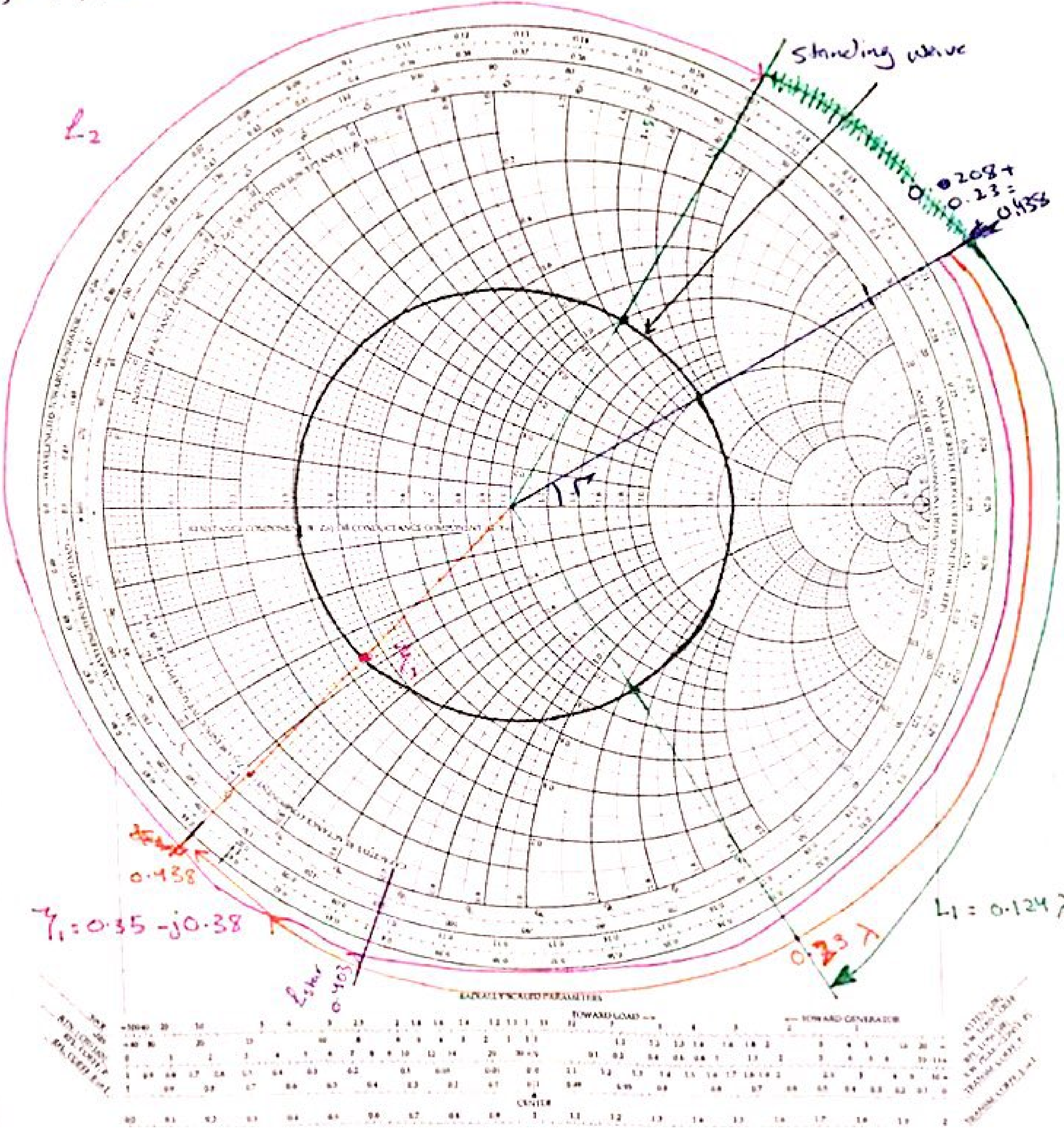


Z_L
$y_1 = 1 + jx$

نصف قطر الدائرة صغير
نص قطر دائرة ٧ كبير

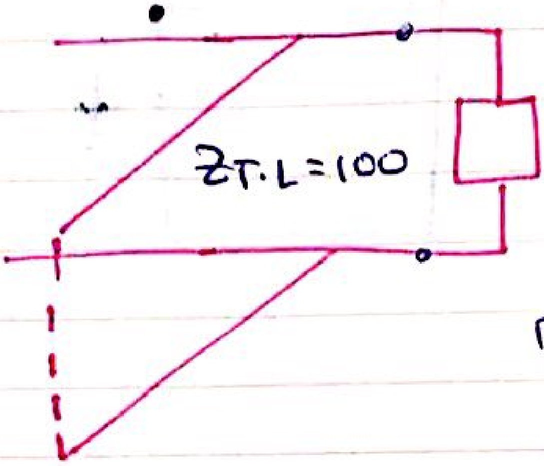
The Complete Smith Chart

Black Magic Design



7/8/
MON

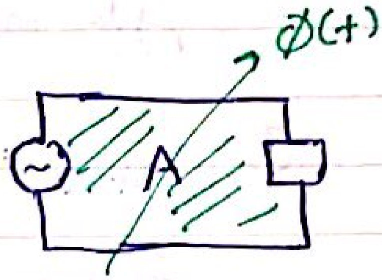
Parallel Matching :::-



$Z_L = 50 + j75$

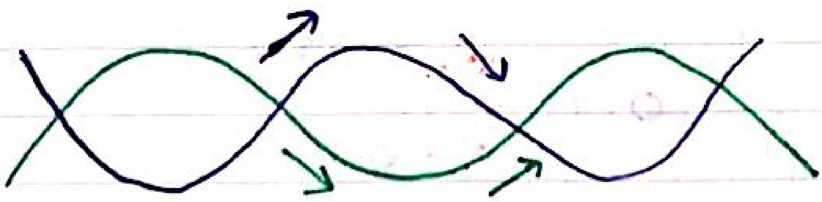
$z = 0.5 + 0.75j$

اي T.L برسل عل freq عالي



$$n(t) = \frac{\partial A \phi(t)}{\partial t}$$

→ [Interference]

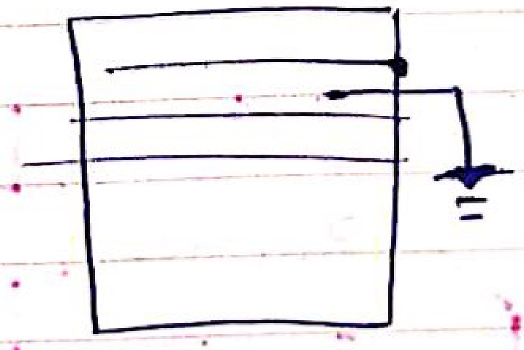


They will almost cancelled each other and endup with Almost Zero interference.

58

* Another sol:-

Grounding



المسافة بين كل
strip و strip
هي ال thickness تبع البورد
فالمسافة قليلة جداً
وال interference قليل .

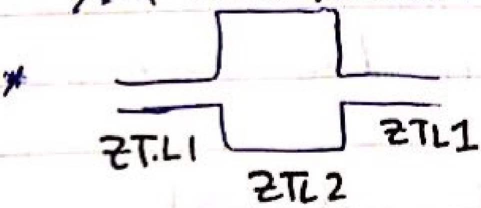
① $y_{stub} = -j1.3$

$z_{stub} = +j0.76$ — S.C → 0.102λ ; O.C → 0.352λ

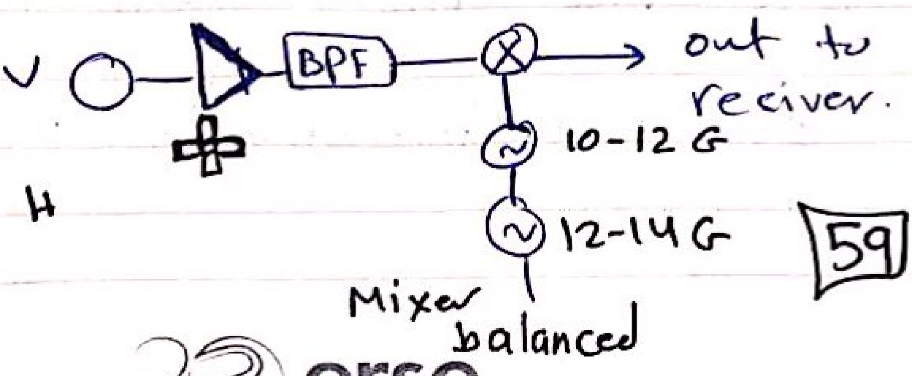
② $y_{stub} = +1.3j$

$z_{stub} = -j0.76$ — S.C → 0.398λ ; O.C → 0.148λ

$\lambda/4$ transformer



* L-M 7806 regulator



Ex 7/8 MON

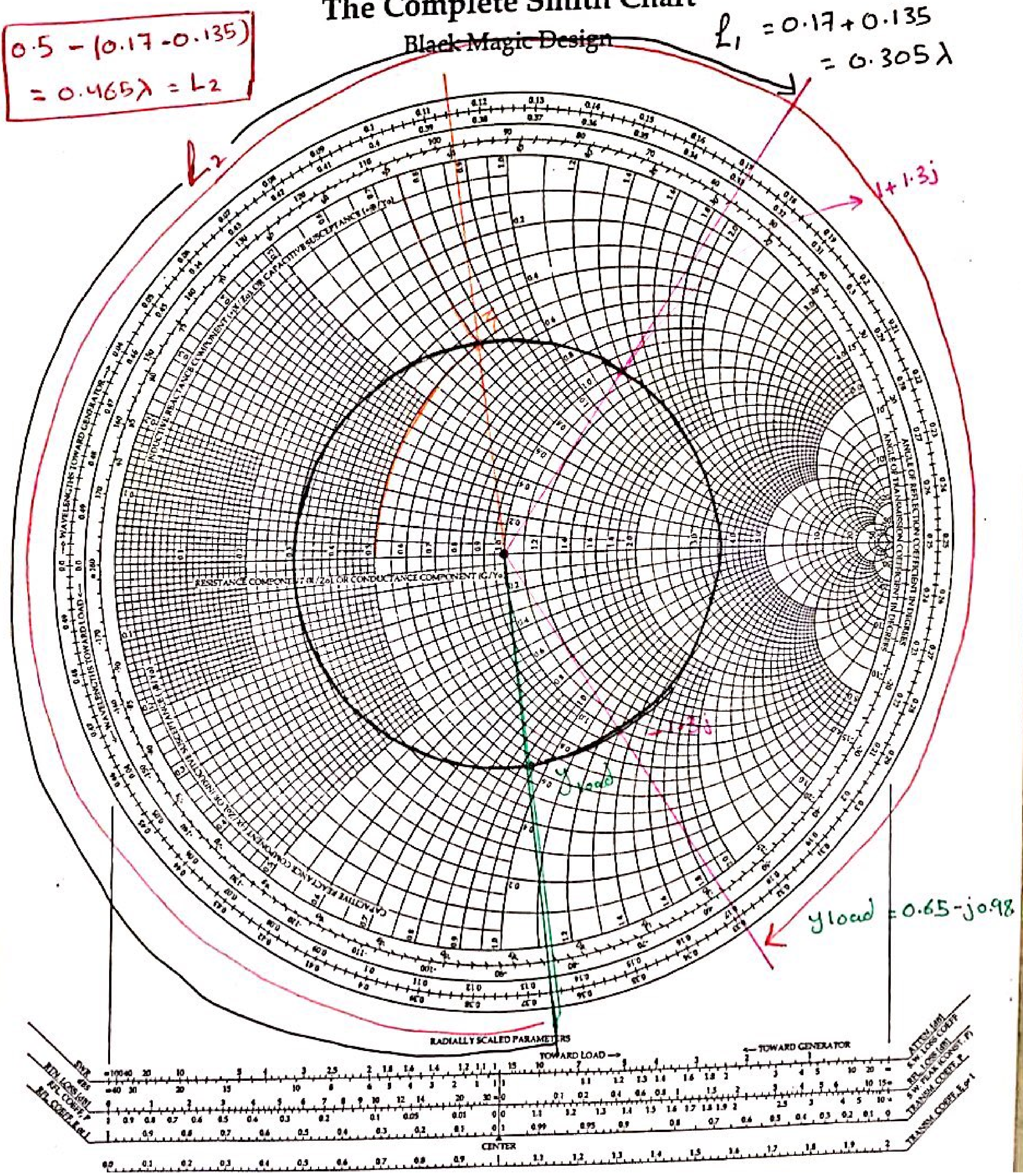
Parallel Matching

The Complete Smith Chart

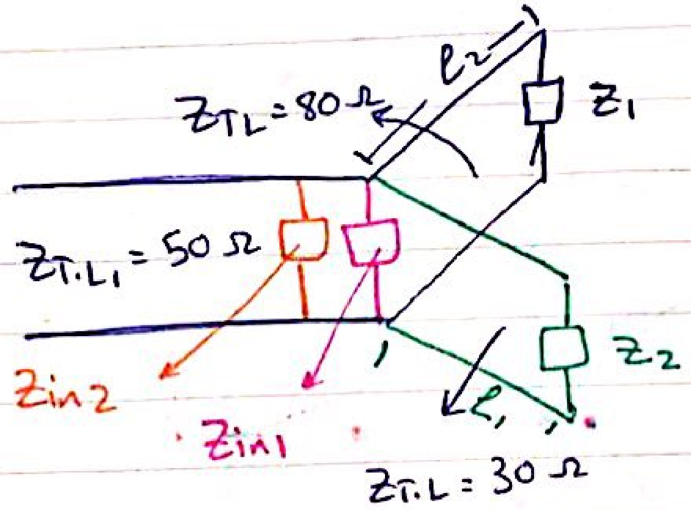
Black Magic Design

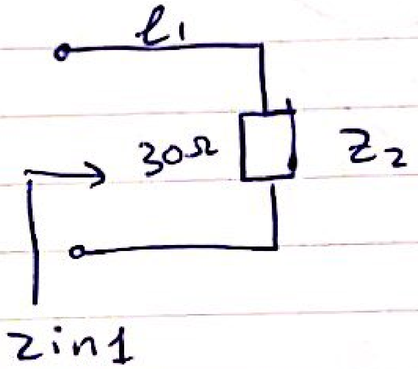
$0.5 - (0.17 - 0.135) = 0.465\lambda = L_2$

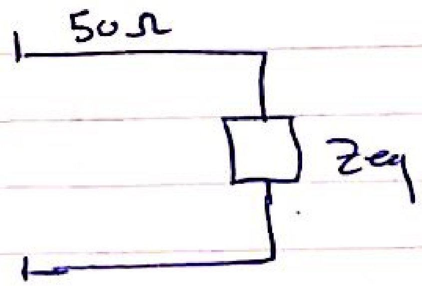
$L_1 = 0.17 + 0.135 = 0.305\lambda$



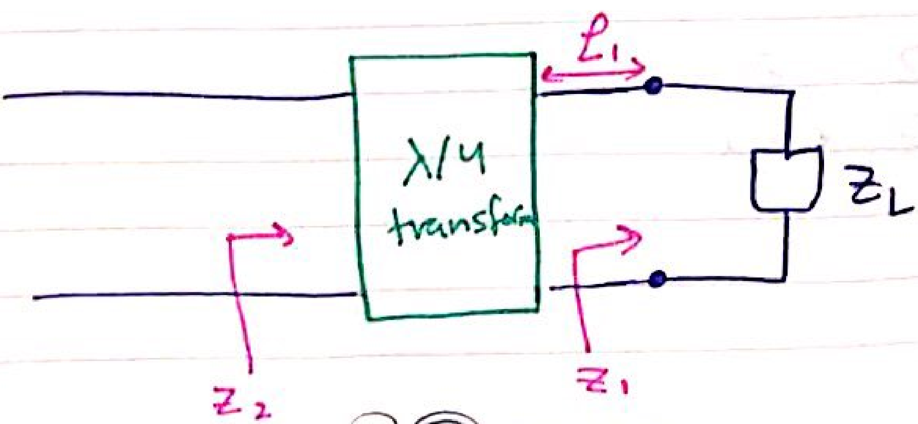
8/8 Tue

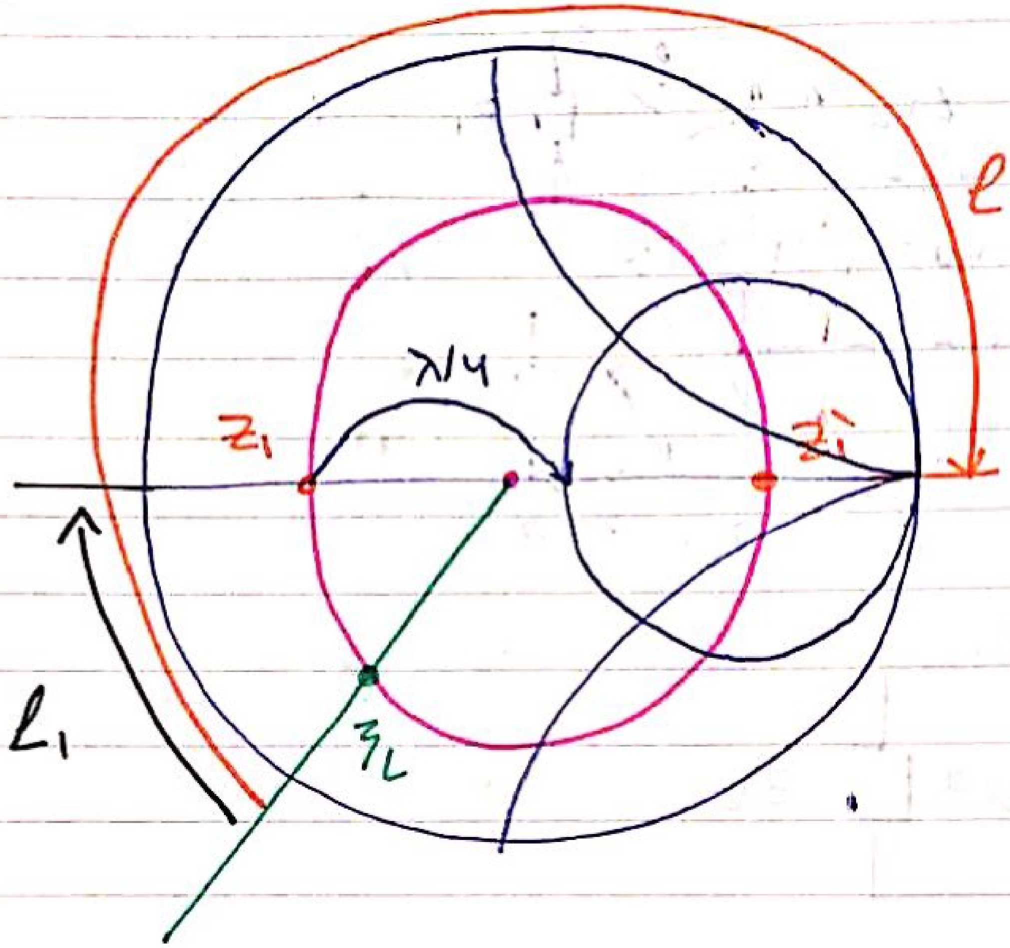






* $\lambda/4$ Transformer:-



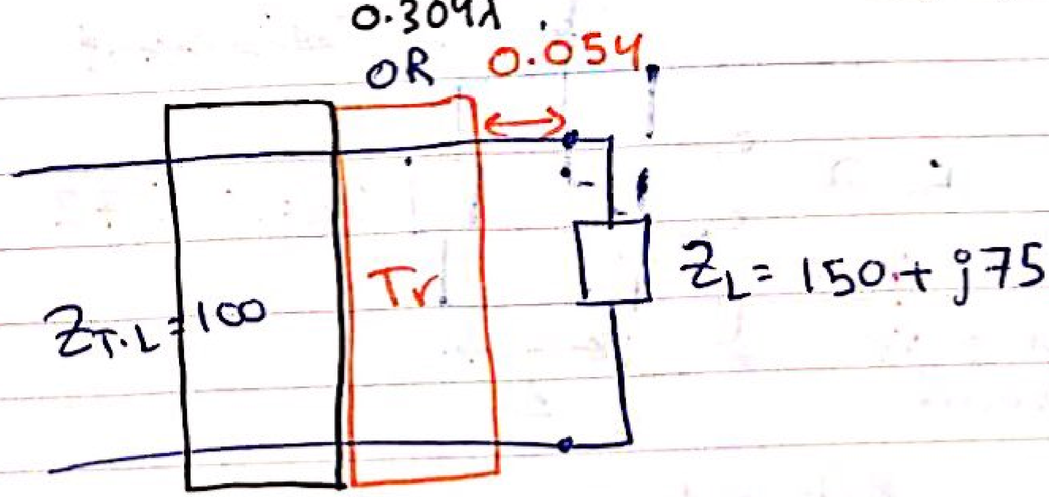


$R_{in} = n^2 R_L$

$$Z_{\lambda/4} = \sqrt{Z_2 \cdot Z_1}$$

$Z_2 = Z_{T.L}$
Z_1 real

Ex



$z_L = 1.5 + j0.75$

$0.25 - 0.196 = 0.054\lambda$

$z_1 = 1.95$

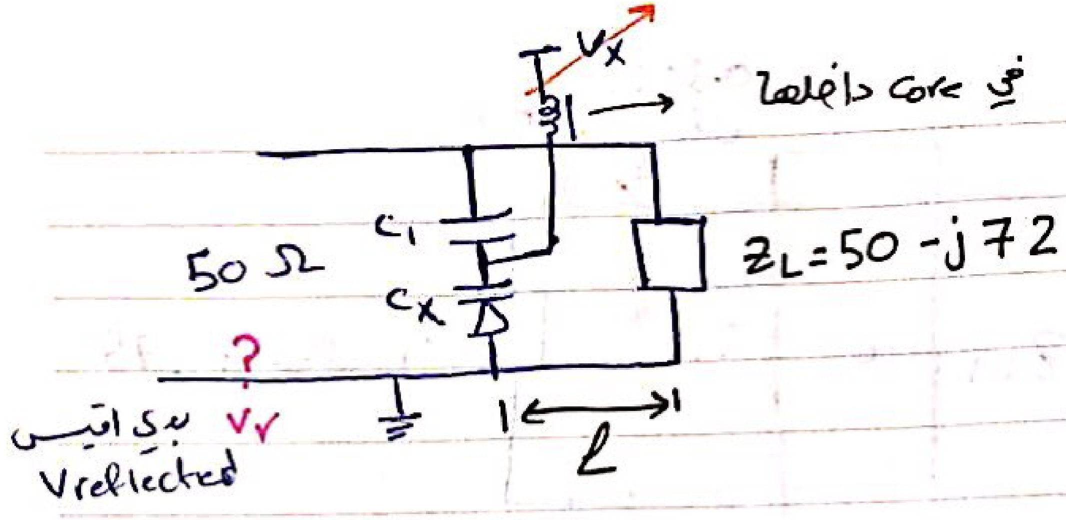
$Z_1 = 195\ \Omega$.

$Z_{Tr} = \sqrt{100 * 195} = 139\ \Omega$

$l_1' = 0.304\lambda$

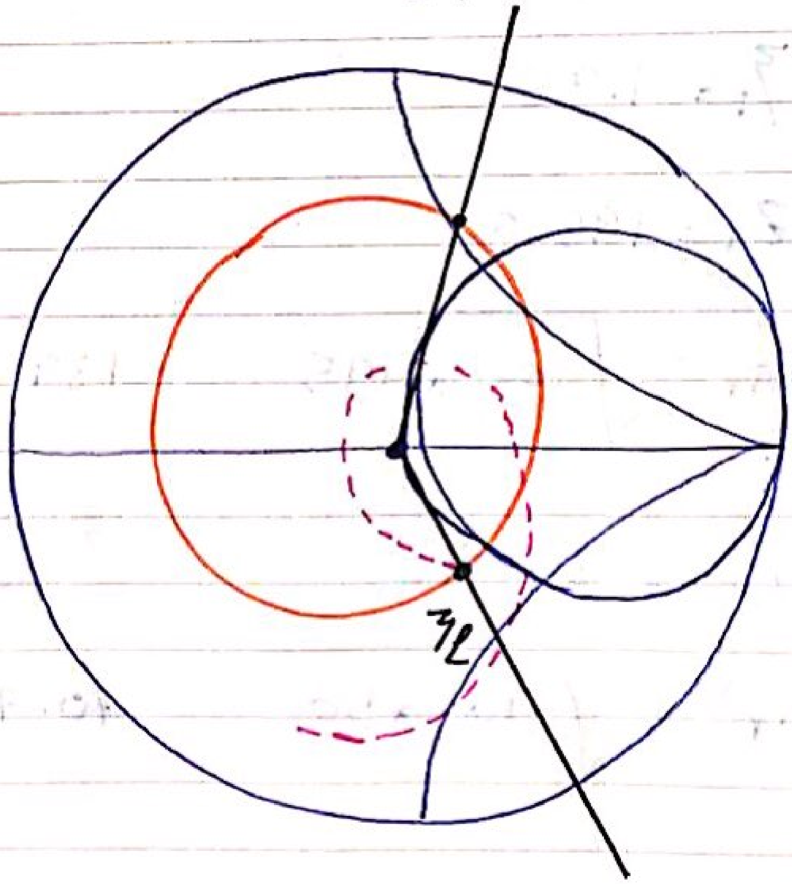
$Z_{Tr}' = \sqrt{100 * 50} = 70.7\ \Omega$

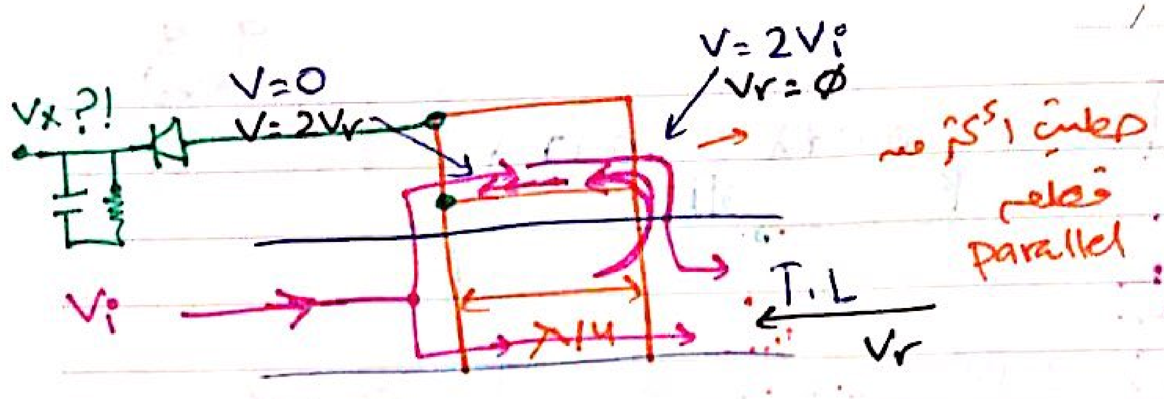
* Directional Coupler D.C :



not a linear inductance we can't use for communication.

* بتحكم بـ capacitance بتغير الـ Vx .

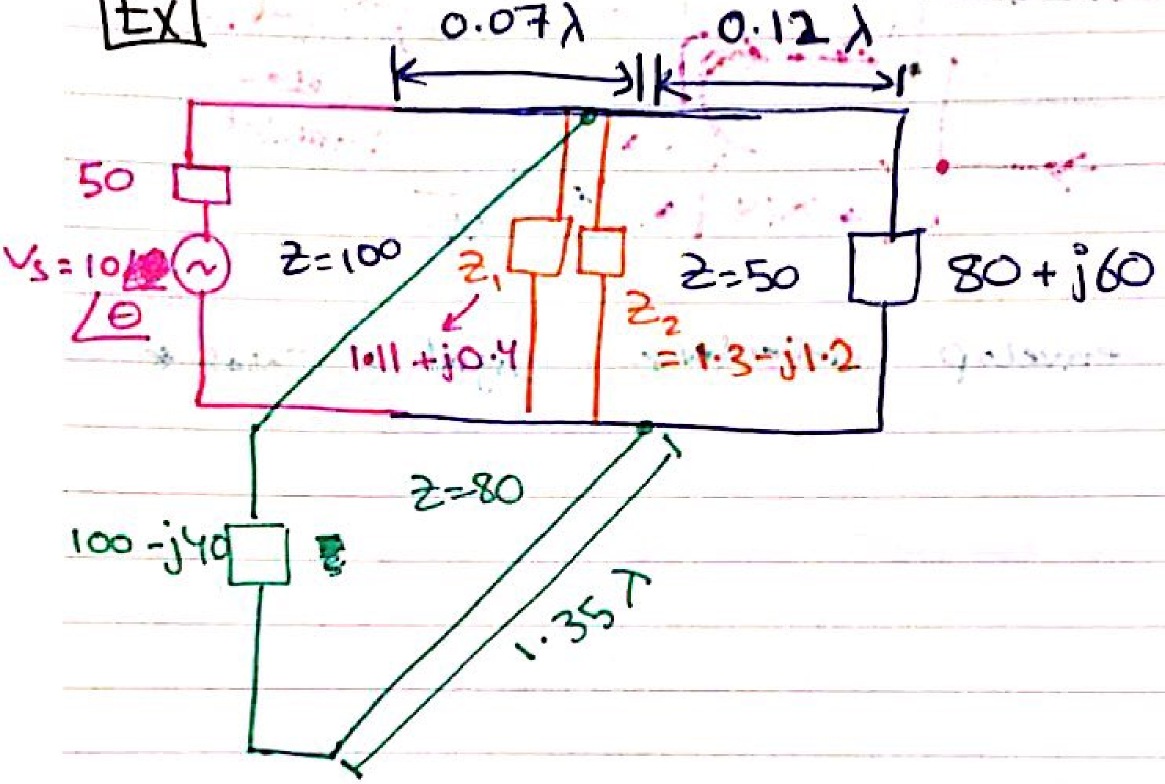




* عملت لل signal ← detecter envelop

9/8/ Wed

Ex

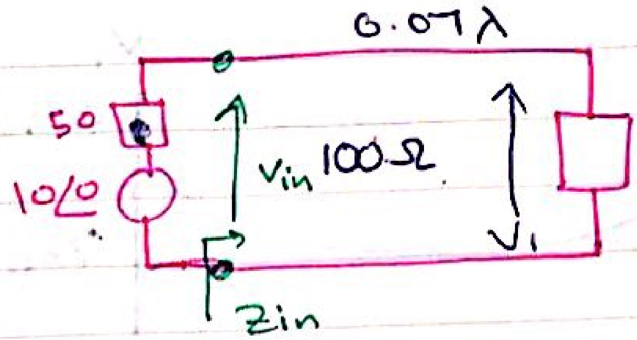


$$\frac{80 + j60}{50} = 1.6 + j1.2 \quad z_1$$

$$\frac{100 - j40}{80} = 1.25 - j0.5 \quad z_2$$

$Z_2 = 65 - j60$

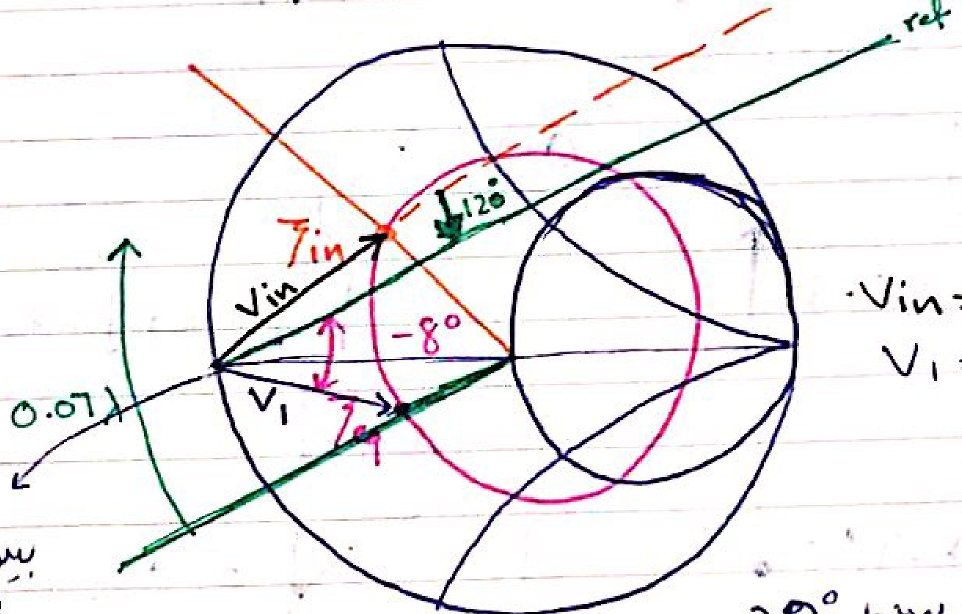
$Z_1 = 88.8 + 32j$



$Z_{eq} = Z_1 // Z_2$

$Z_{eq} = 52.13 - j11.6$

$z_{eq} = 0.52 - j\,0.11$



5.5
Vin = cm
$V_1 = 5.8$cm

20°
V_1 بين
Vin و

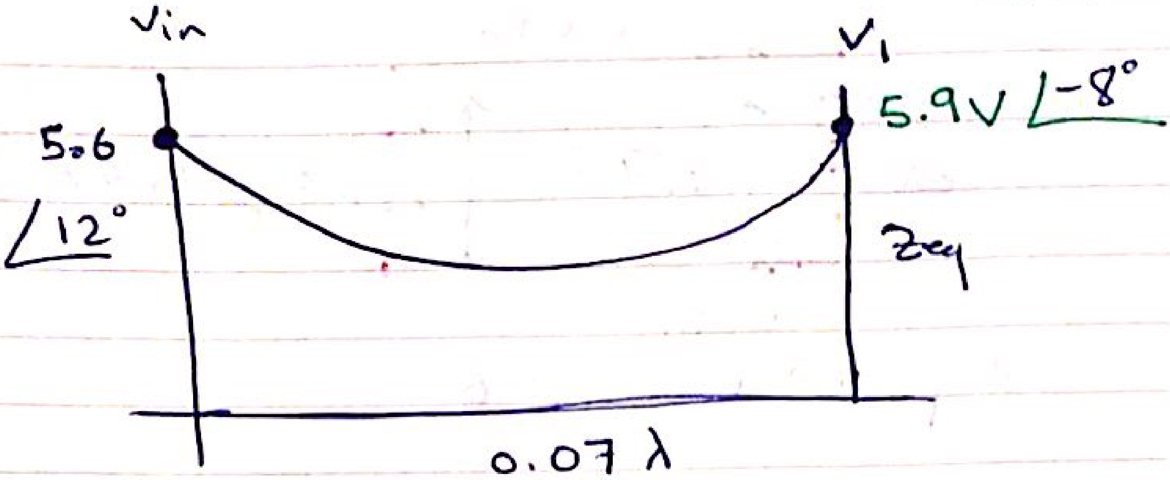
20° btw V_1 و Vin

الزاوية بين V_1 و ref
$12 - 20 = -8°$

$z_{in} = 0.55 + j0.28$

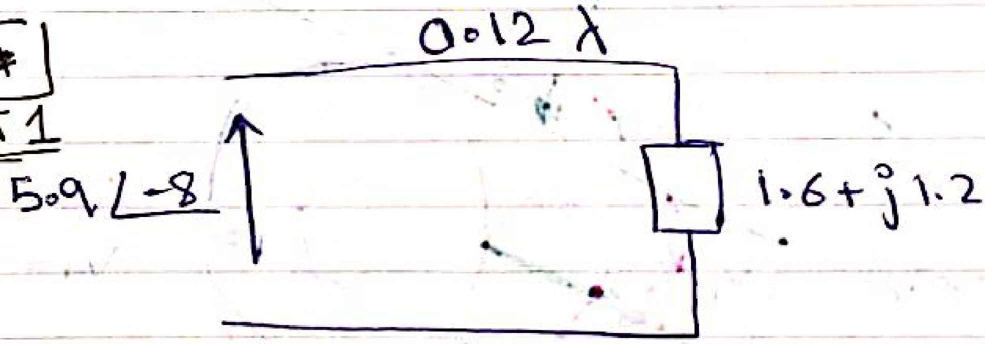
$Z_{in} = z_{in} * 100$
$= 55 + 28j$

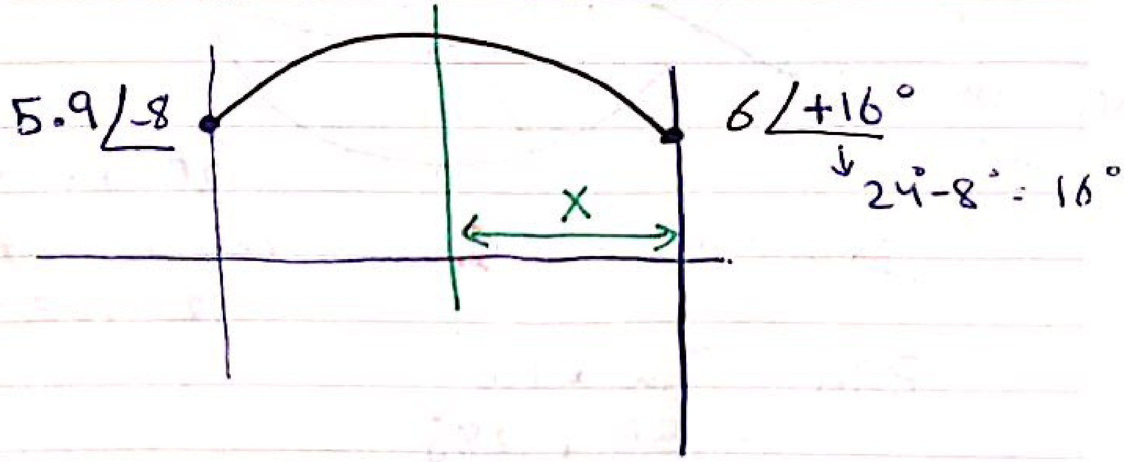
$$V_{in} = \frac{10\angle 0 * 55 + j28}{55 + j28 + 50} = 5.6\angle 12°$$



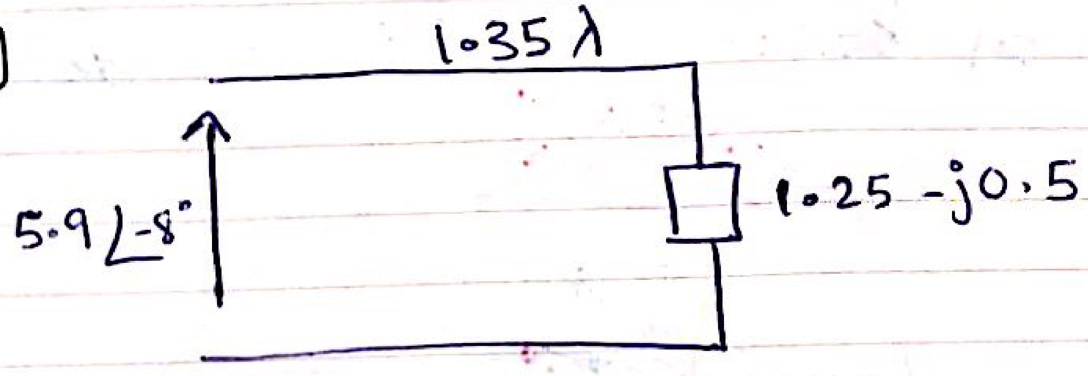
$$V_1 = \frac{5.8}{5.5} * 5.6 = 5.9\,V \angle -8^\circ$$

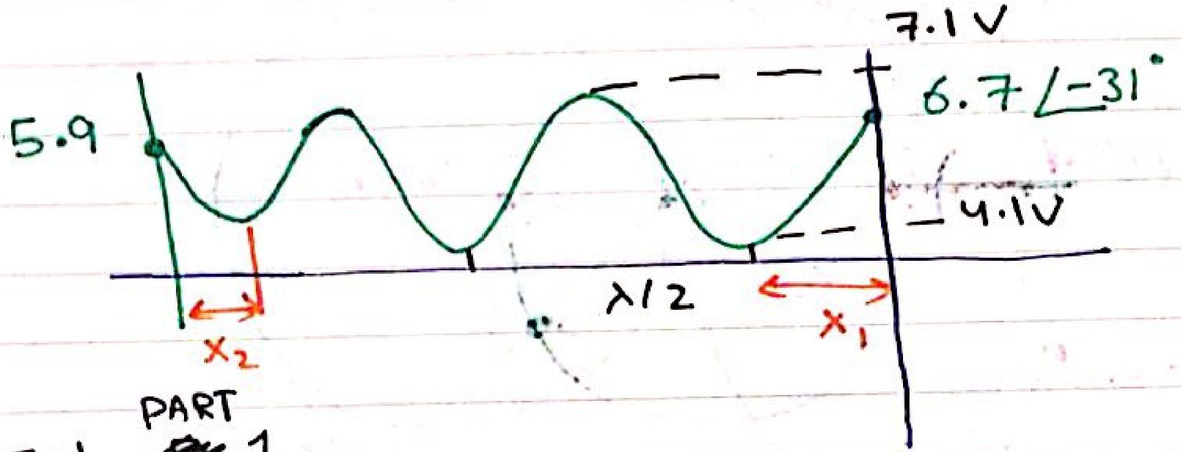
PART 1





PART 2

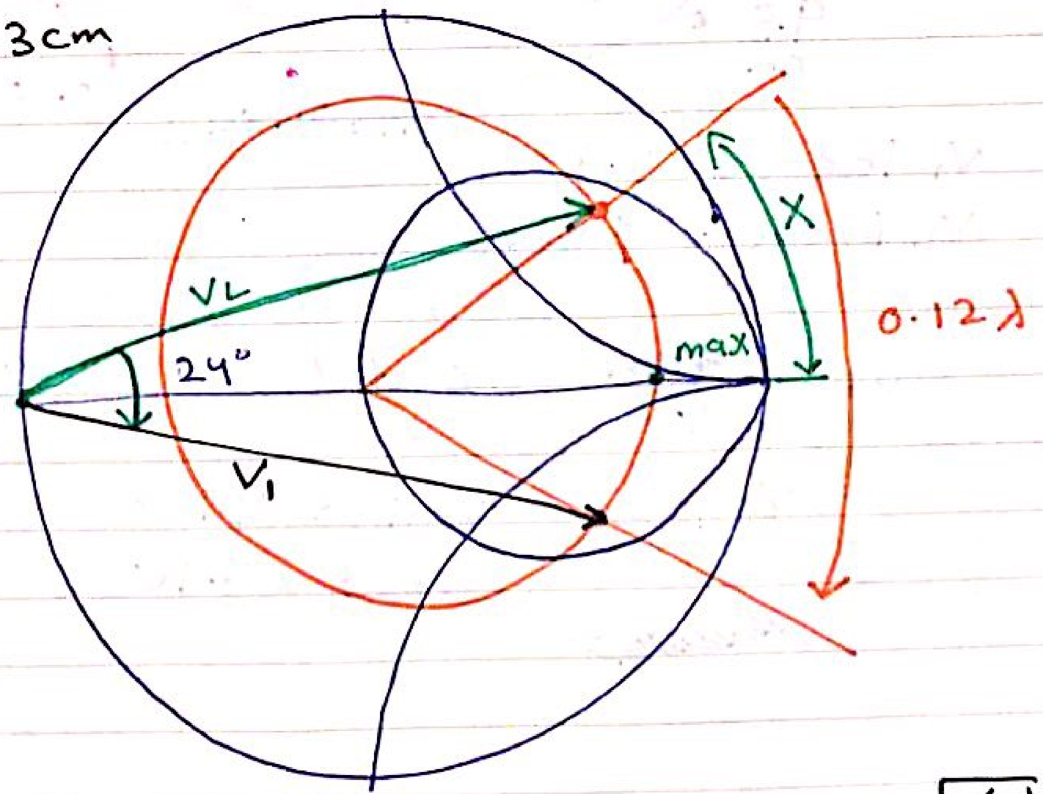




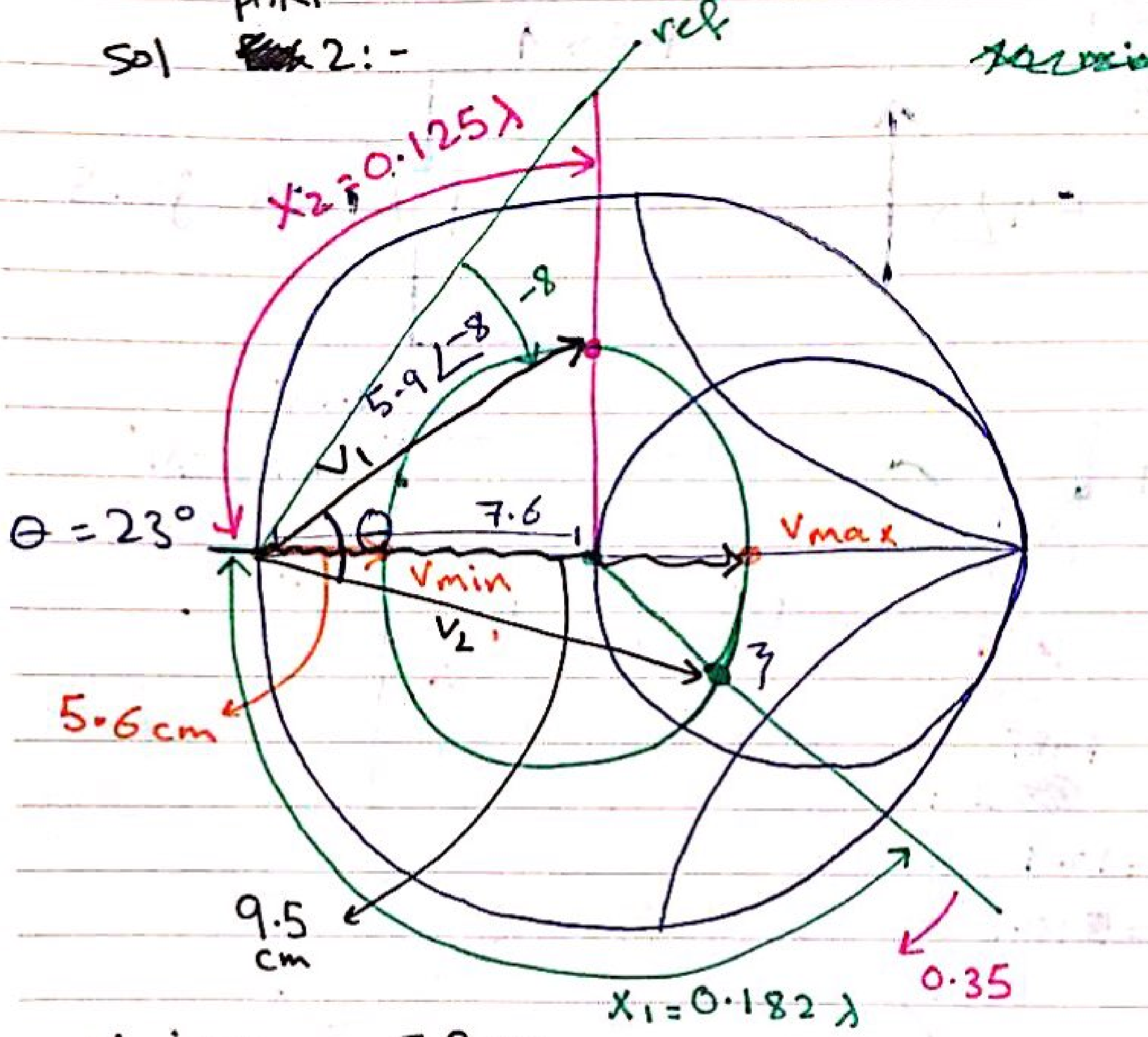
Sol PART 1:-

$V_L = 10.9$ cm

$V_1 = 10.3$ cm



Sol PART 2 :-



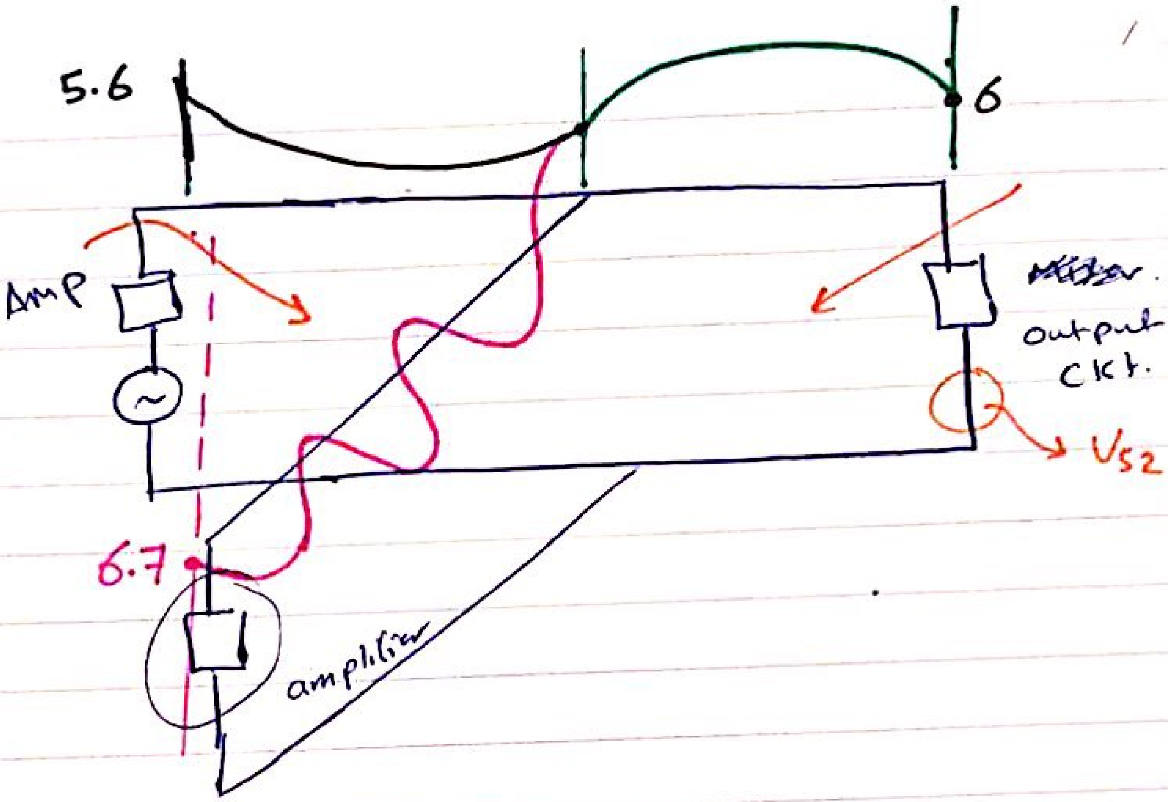
V_1 in cm = 7.9 cm

V_L in cm = 9 cm

$V_L = 6.7 \angle -31$ (-8 - 23)

Vmin = 4.1 V

Vmax = 7.1V

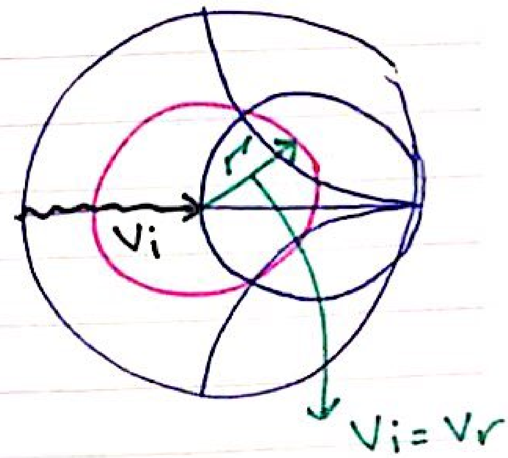


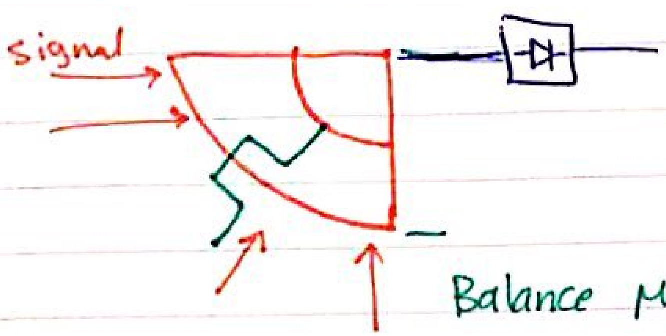
$$VSWR = \frac{V_{max}}{V_{min}}.$$

Ratio btw اكبر نقطة واقرب نقطة

$$VSWR = \frac{7.1}{4.1} = 1.73 \geq 1$$

$$VSWR = \frac{V_i + V_r}{V_i - V_r}.$$

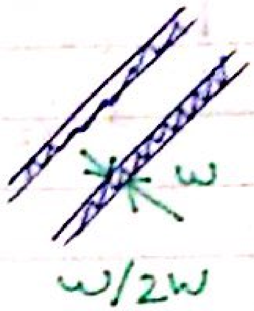




10.8.
Thur

In Inductive $jX_L = +ve$

admitance $y = \frac{1}{jX} = -ve$ in parallel



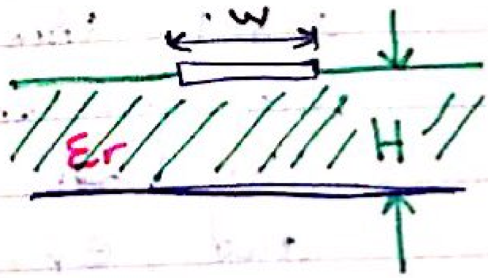
$W \to 2W$

bus

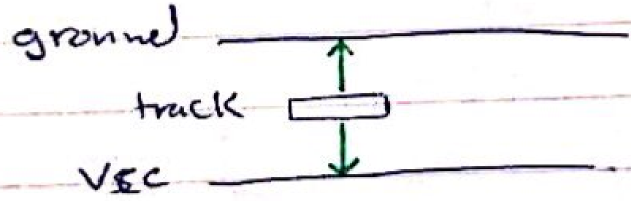
W → track
└→ ground

Micro strip:-

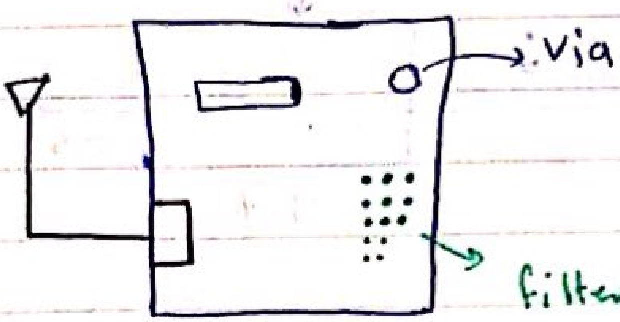
$$Z = \frac{377}{\sqrt{\varepsilon_r}\left(\frac{W}{H} + 2\right)}$$



H btw ground and track.



* FR4 ⇒ $\varepsilon_r = 4.4$



↑size → ↓ resonance freq

Size ∝ λ

ocillator ⇒ freq ↑ → there size ↓

16/8/
Wed

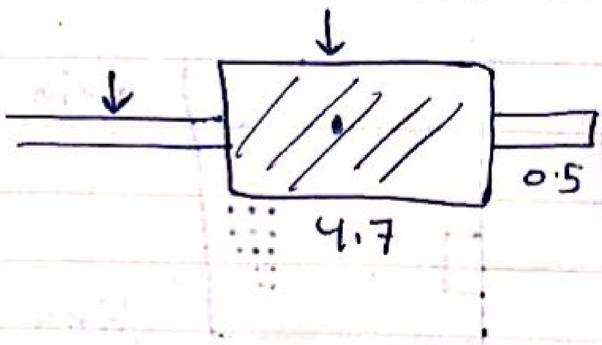
Quiz 5 :-

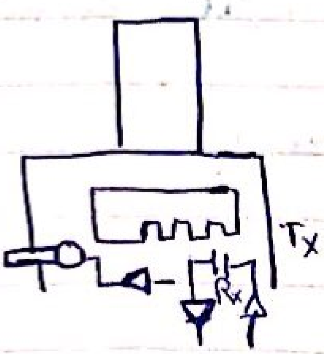
a $\lambda/4$ transformer has $Z_{Tr} = 35\,\Omega$
find the width of the track if the board highest is 1.5 mm and $\epsilon_r = 4.4$??

Sol :-

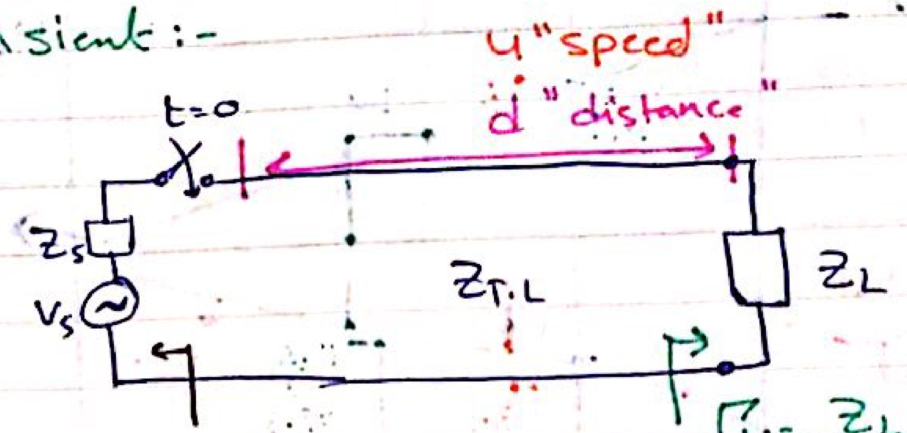
$$35 = \frac{377}{\sqrt{4.4}\left(\frac{w}{h} + 2\right)}$$

$w = 4.7$ mm.



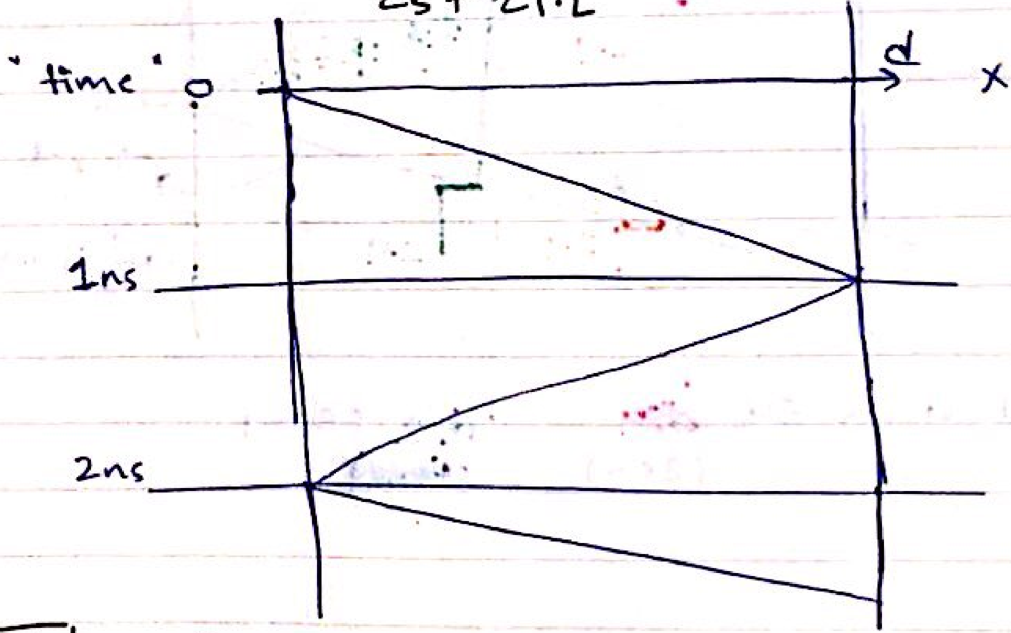


* Transient :-

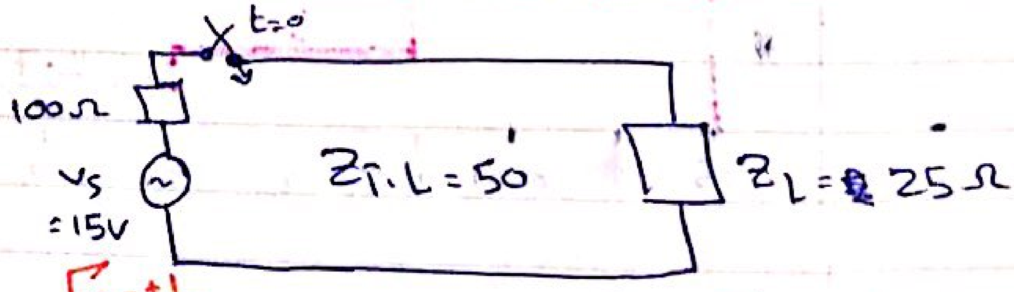


$$\Gamma_L = \frac{Z_L - Z_{T.L}}{Z_L + Z_{T.L}}$$

$$\Gamma_s = \frac{Z_s - Z_{T.L}}{Z_s + Z_{T.L}}$$

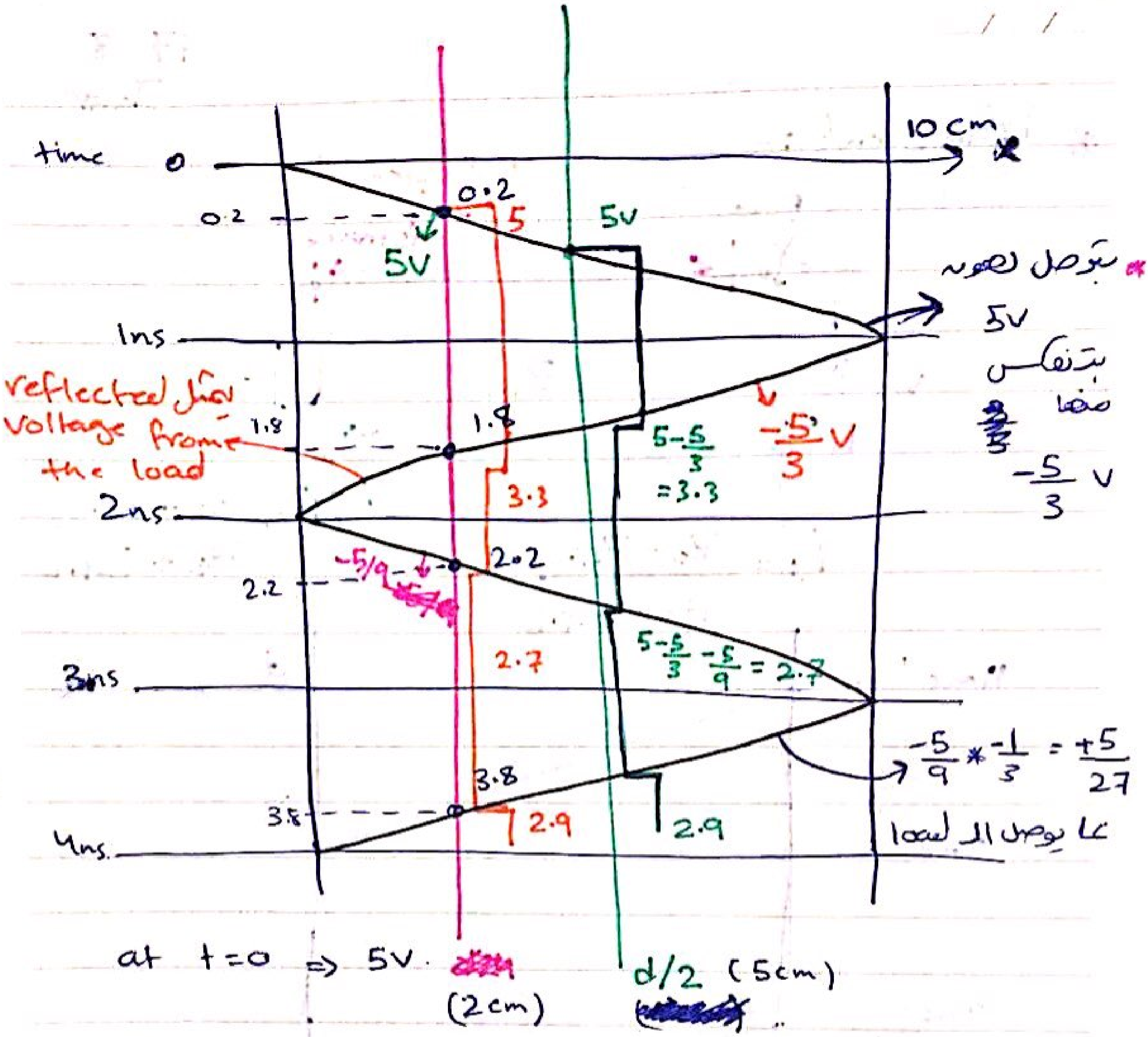


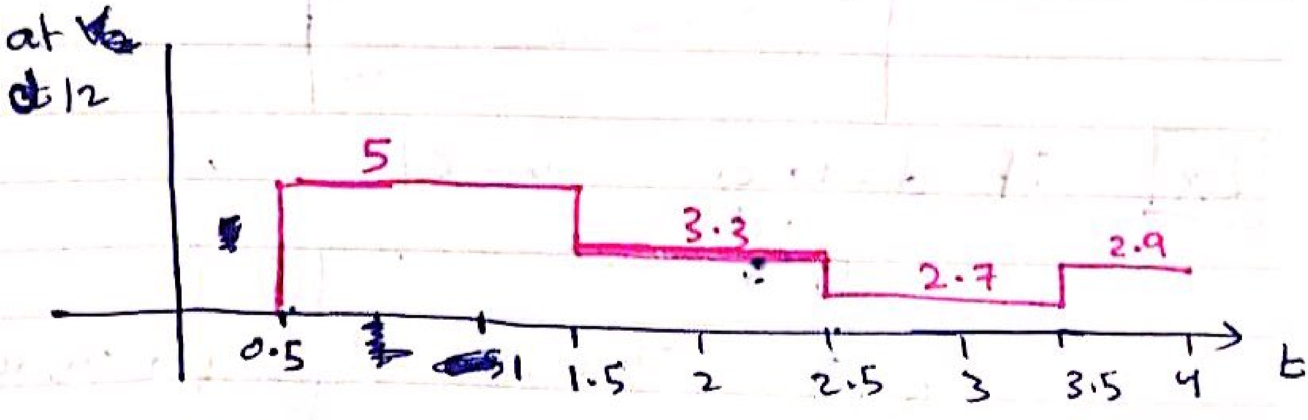
Ex if $d = 10$ cm $u = C/3$

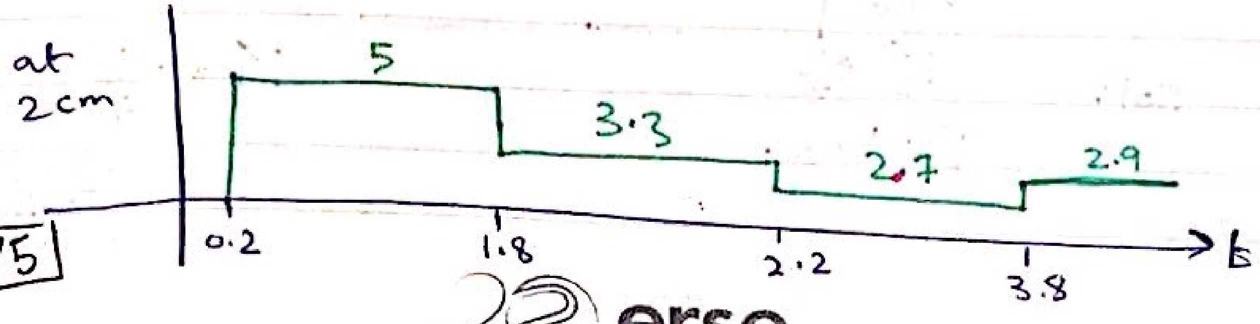


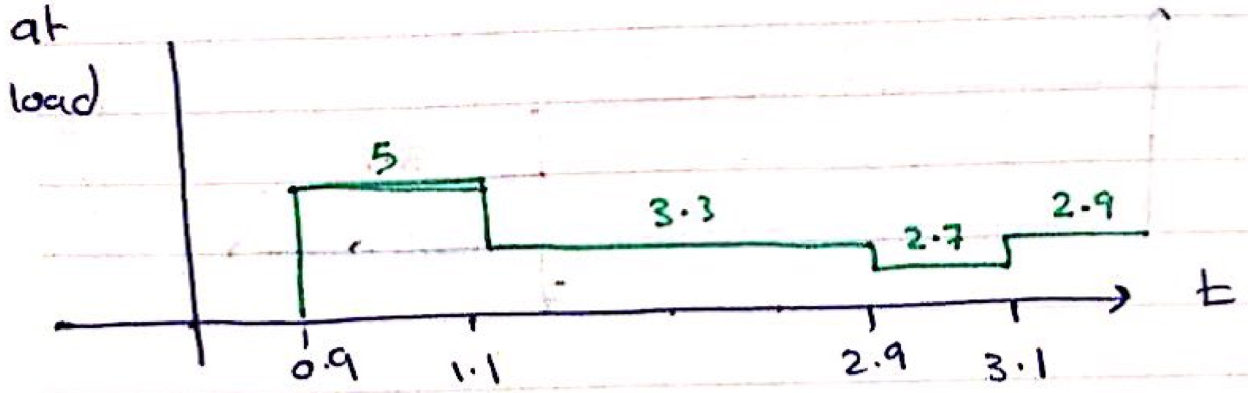
Sol: $\Gamma_s = +\frac{1}{3}$ $\Gamma_L = -\frac{1}{3}$

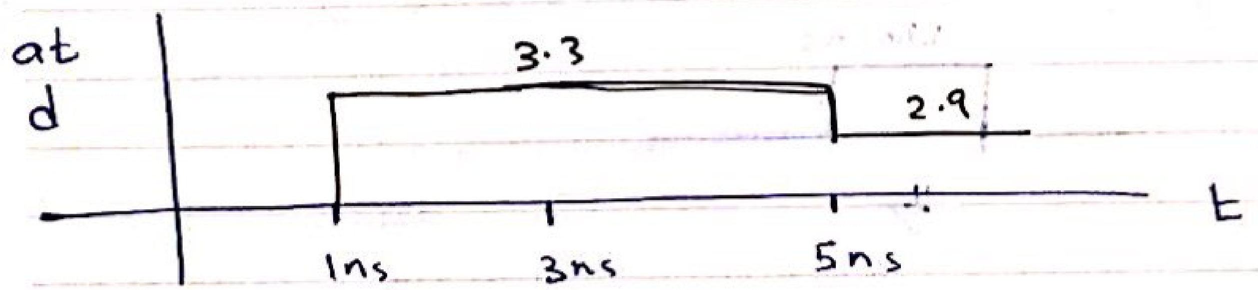
$T = 1ns$.

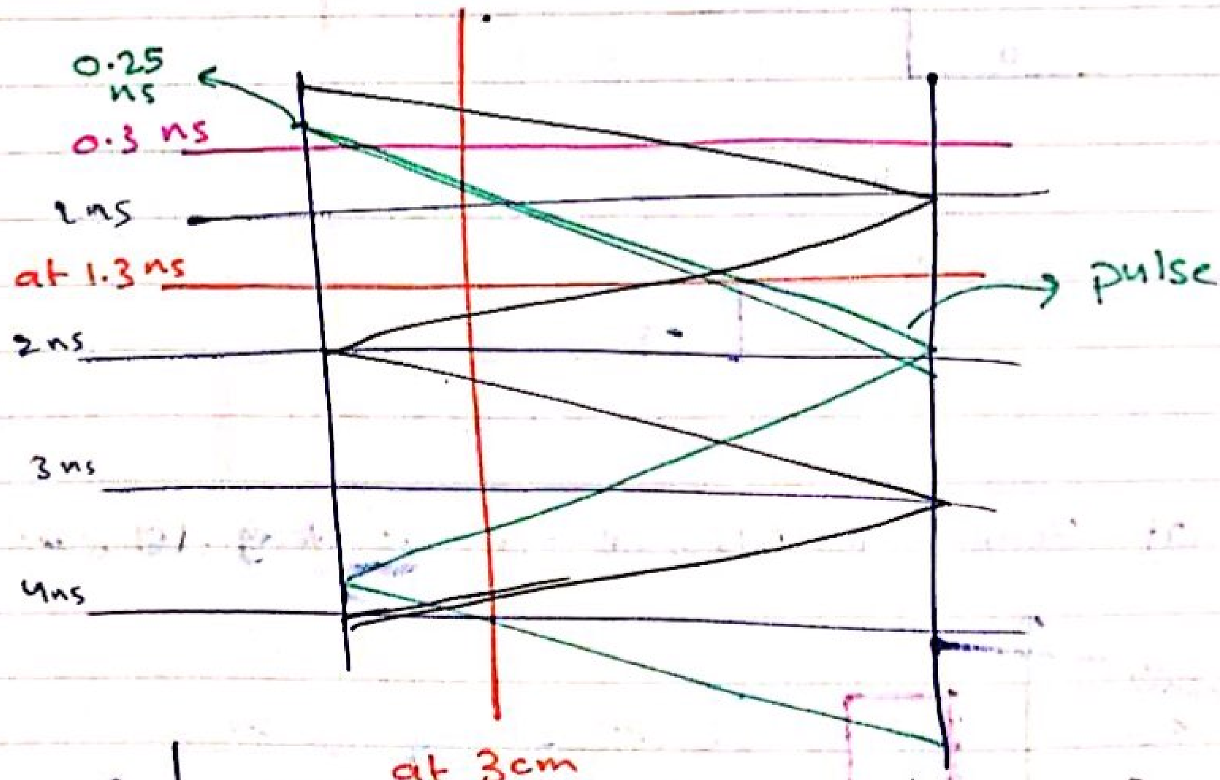

time
0
10 cm
x
0.2
5
5V
1ns
reflected
voltage from
the load
1.8
$5-\frac{5}{3}$
$=3.3$
$-\frac{5}{3}$ V
2ns
3.3
2.2
2.7
$5-\frac{5}{3}-\frac{5}{9}=2.7$
3ns
$-\frac{5}{9} * -\frac{1}{3} = +\frac{5}{27}$
3.8
2.9
4ns
at t=0 => 5V
(2cm)
d/2 (5cm)

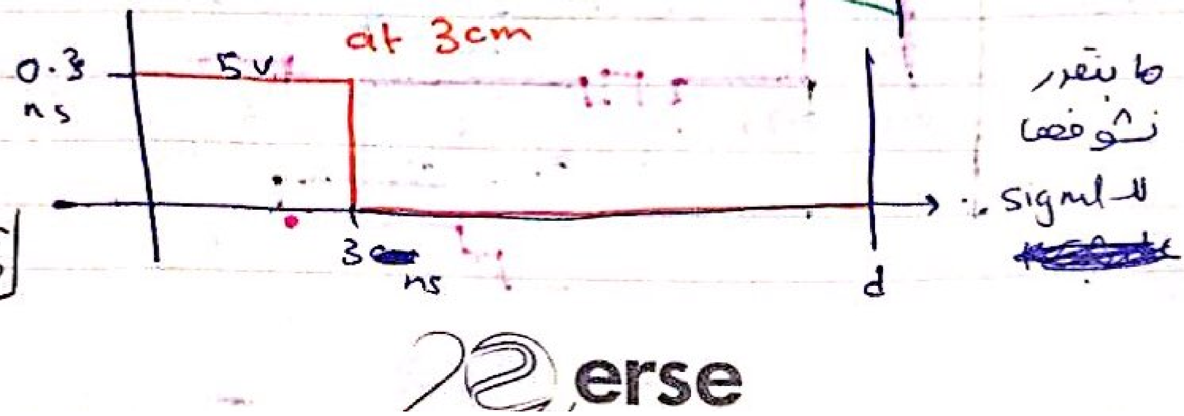

at
d/2
5
3.3
2.7
2.9
0.5
1
1.5
2
2.5
3
3.5
4
t


at
2cm
5
3.3
2.7
2.9
0.2
1.8
2.2
3.8
t

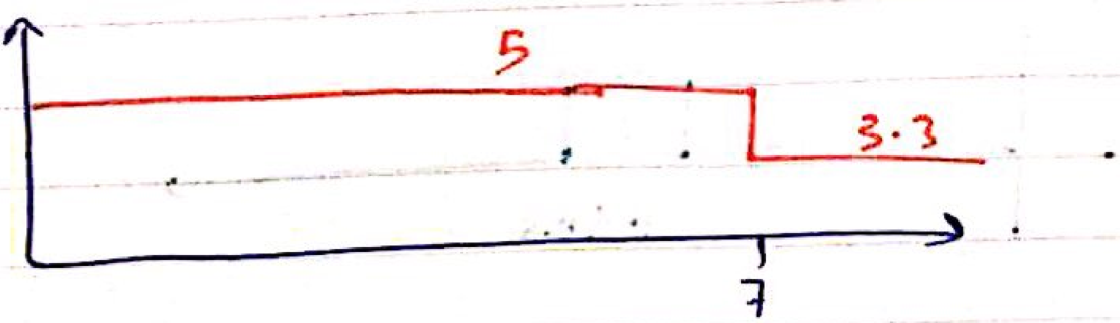

at load
5
3.3
2.7
2.9
t
0.9
1.1
2.9
3.1


at d
3.3
2.9
t
1ns
3ns
5ns

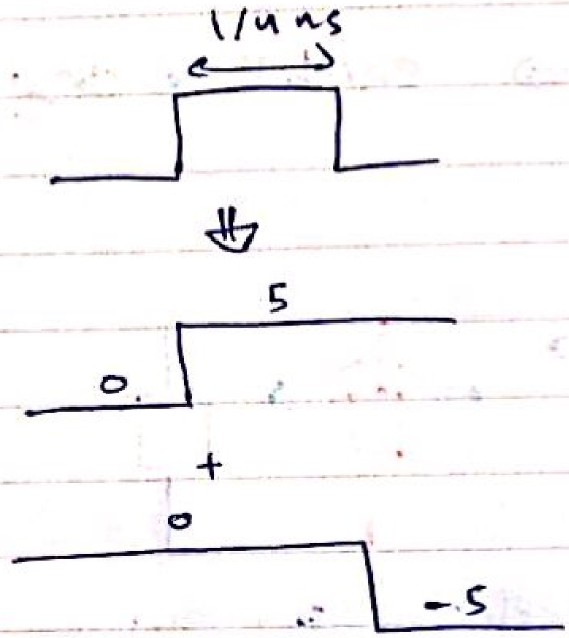

0.25 ns
0.3 ns
1ns
at 1.3ns
2ns
3ns
4ns
pulse


at 3cm
0.3 ns
5V
3 ns
d
ما بتغير
نشوفها
لـ signal

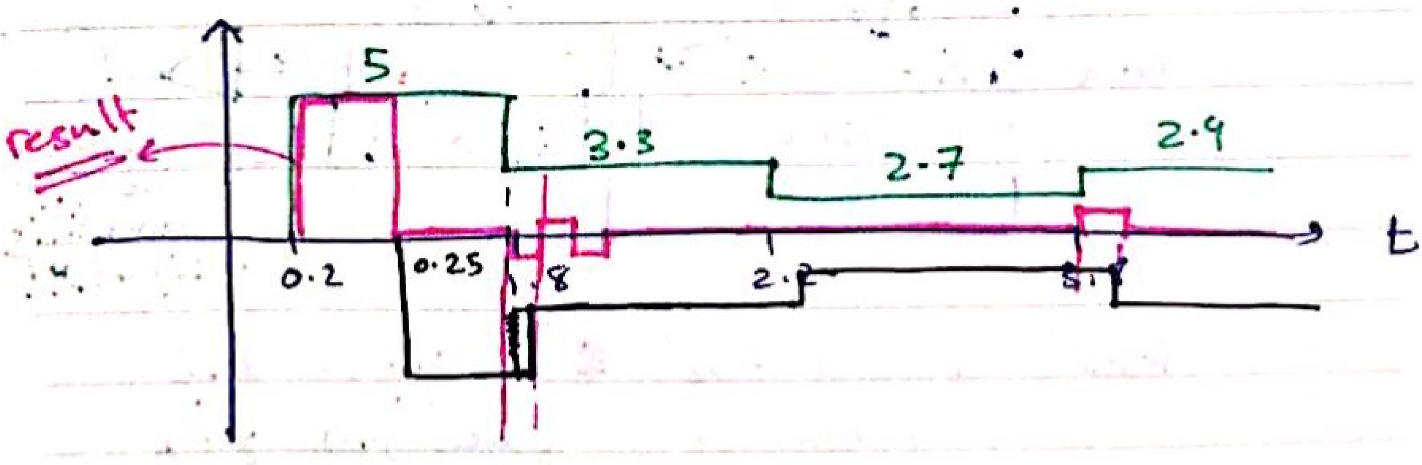
at 1.3 ns



pulse



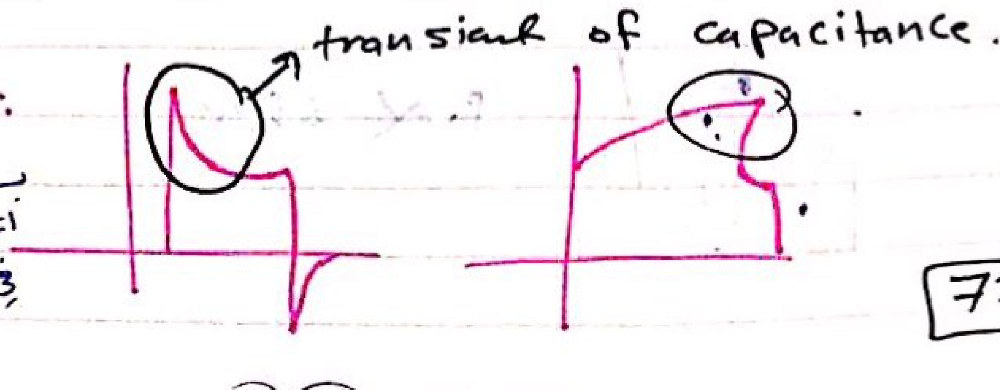
بدي اعمل delay بمقدار 0.25 للعينة لحالها ⇐ at "2cm"

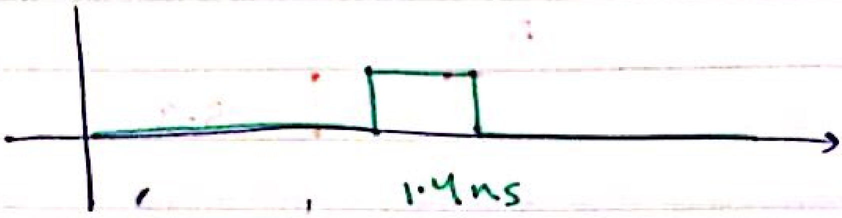


TDR:

⇓

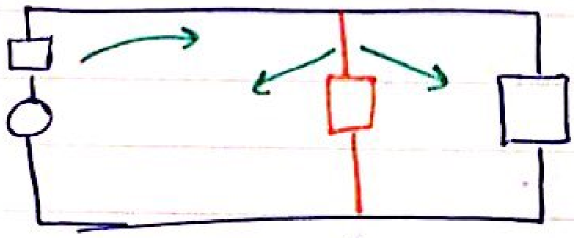
بستخدمو عشان اعرف وين الخلل في الكيبل.



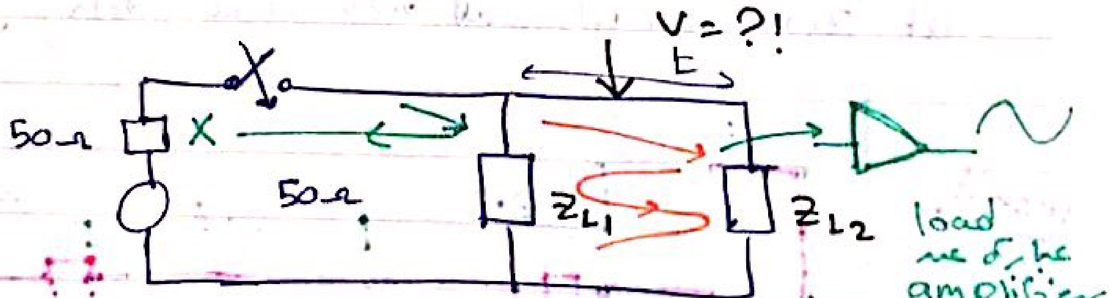


* inductive ⇒ earth يصير له يوصل مع ال

* add load

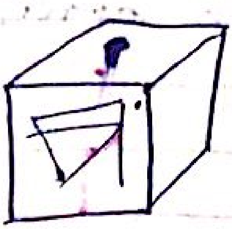


signal رح تمشي بعضها ~~reflected~~ وجزء يمر جزء

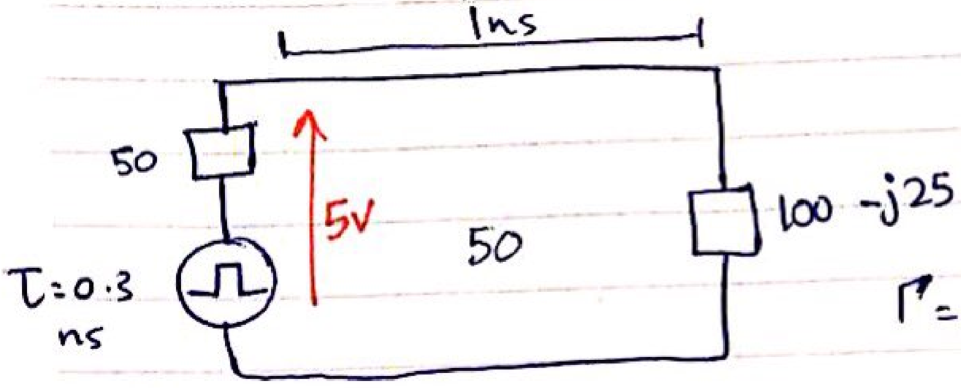


signal ⇒ 2 load تتقسم بين

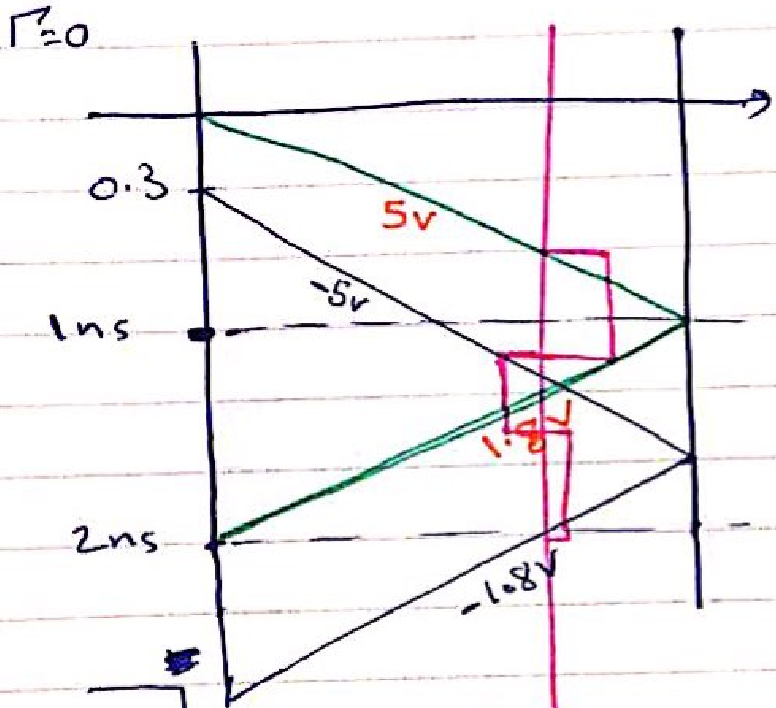
* راح يصير عندي resonance.

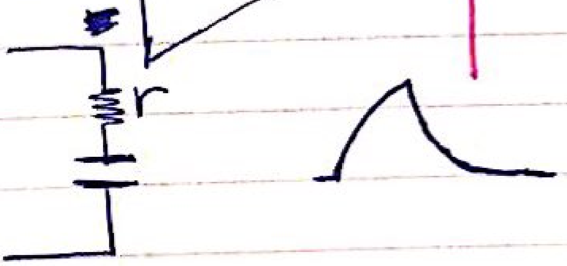


fox size

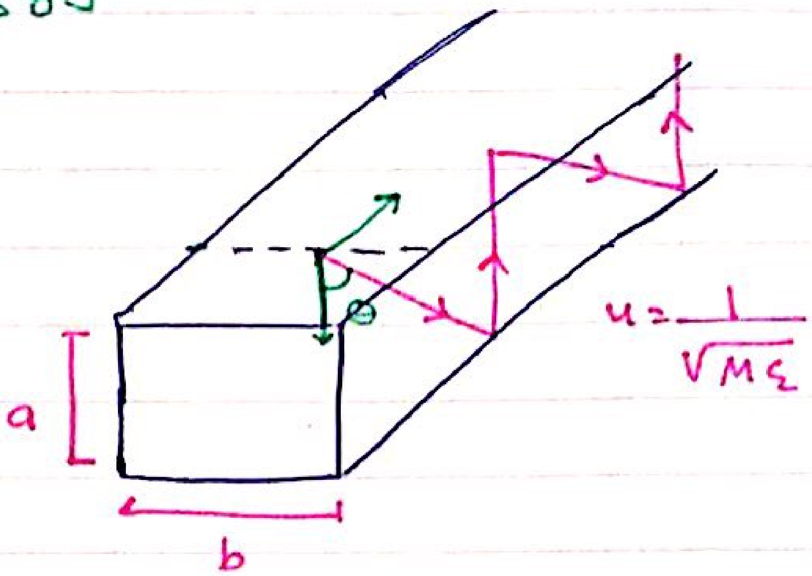


$\Gamma = \frac{50 - j25}{150 - j25} = 0.36\angle{-17}$





Wave Guides 8◁



$b \geq \lambda/2$

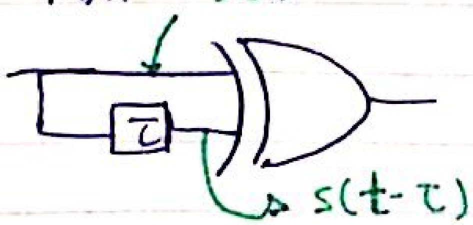
f_{cutoff}

(min freq which ⇒ ($\lambda/2 = b$)

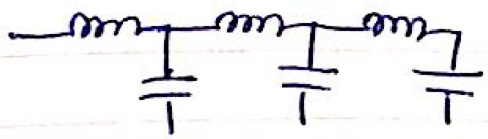
~~$u = \frac{1}{\sqrt{\mu\varepsilon}} * \frac{1}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}}$~~

$$u = \frac{1}{\sqrt{\mu\varepsilon}} \sqrt{1-\left(\frac{f_c}{f}\right)^2}$$

* differential RX:-

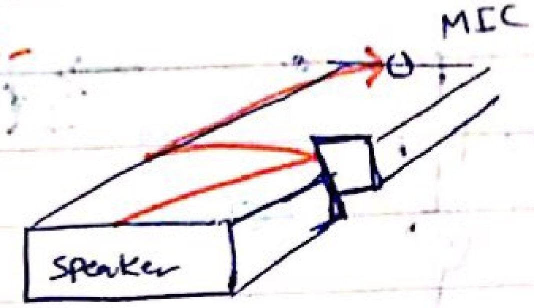


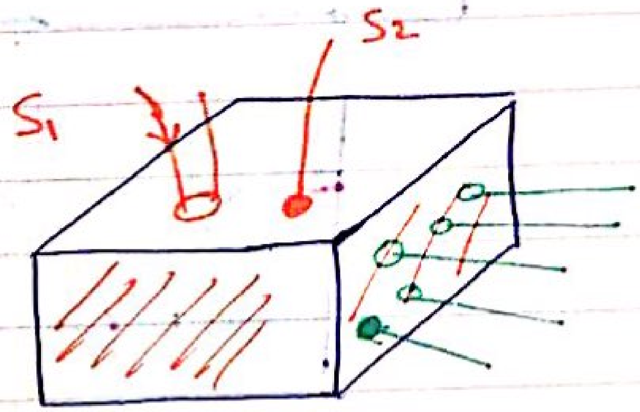
τ



$$y(t) = \sum \alpha_i \cdot s(t - \tau_i)$$

*** SAW Filters:-**

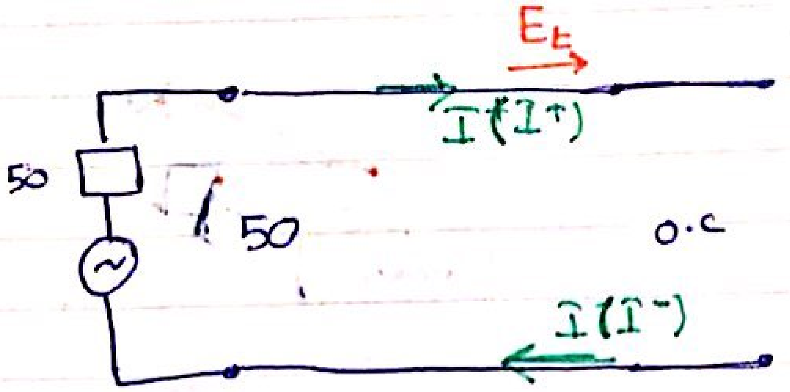


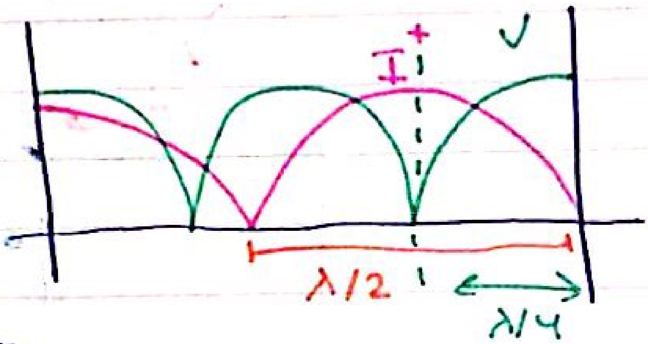


$$\sum \alpha_i s_1(t - \tau_i) + \beta_i \, s_2(t \mp \tau_i)$$

21/8/
MON

Antennas:-



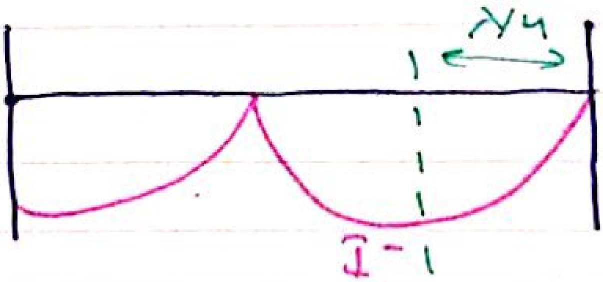


minimum = 0

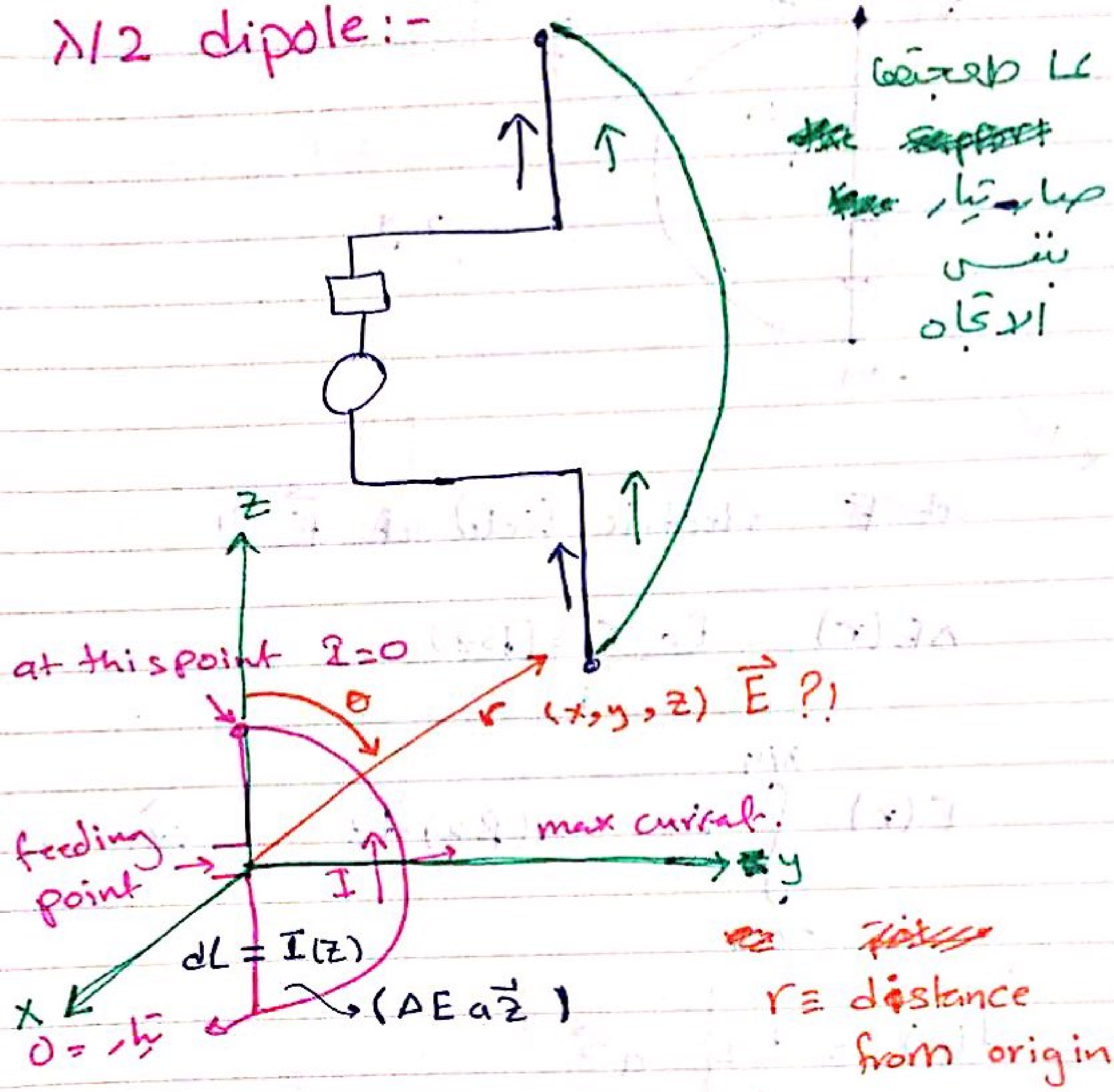
current → give electric field

* في ال antenna فرق current مش voltage .

بعدها بس .



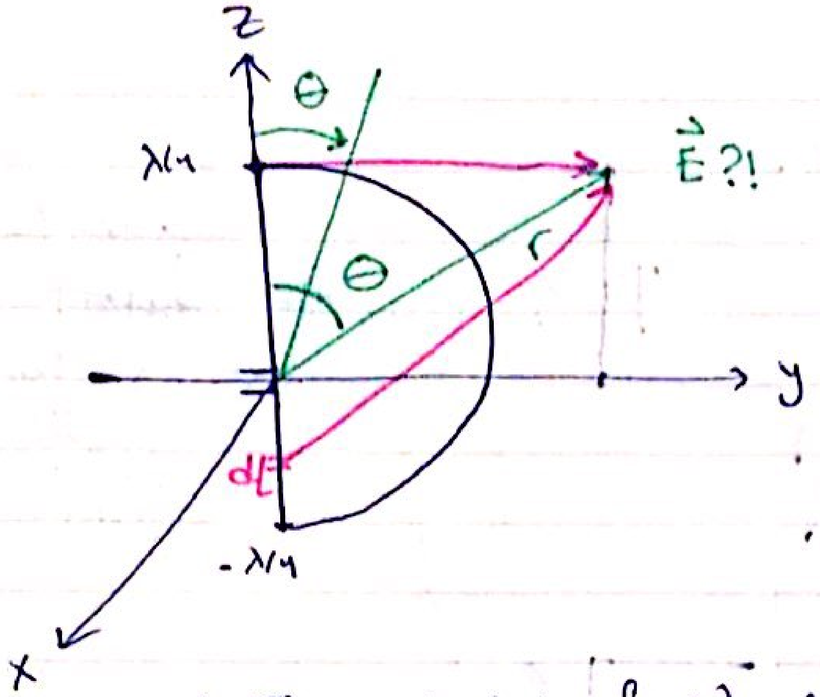
λ/2 dipole:-



$$\Delta E \, \vec{a_z} = I(z) E_0 \, \vec{a_z}$$

$$f(z) = \cos(\beta z)$$

$$\Delta E = E_0 \cos(\beta z)$$



~~dE~~ E electric field at $\vec{E}$?!

$$\Delta E(r) = \frac{E_0 \cos(\beta z)}{r}$$

$$E(r) = \int_{-\lambda/4}^{\lambda/4} \frac{E_0}{r} \cos(\beta z)\, dz \quad \vec{a_z}$$

$$\boxed{E(r) = \frac{E_0}{r} \vec{a_z}}$$

$$E(r) = \frac{E_0}{r} \vec{a_z} \sin\theta$$

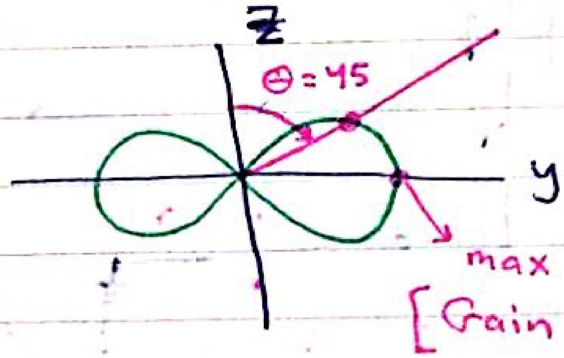
$$\boxed{E(r, \theta) = \frac{E_0}{r} \sin\theta \, \vec{a_z}}$$

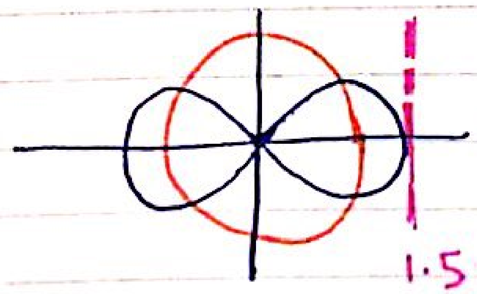
/ /

* اذا كان الشكل مش sinu-siodal ← لا تأثر على قيم Eo

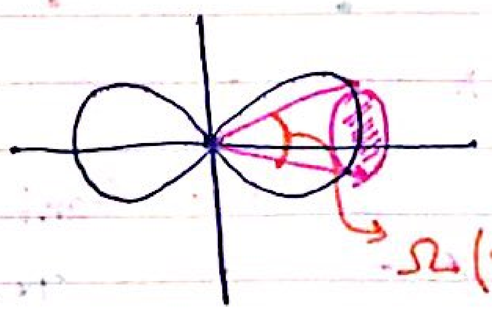
* In Horizontal-plane → radiation pattern مخطط

* In Vertical-plane.





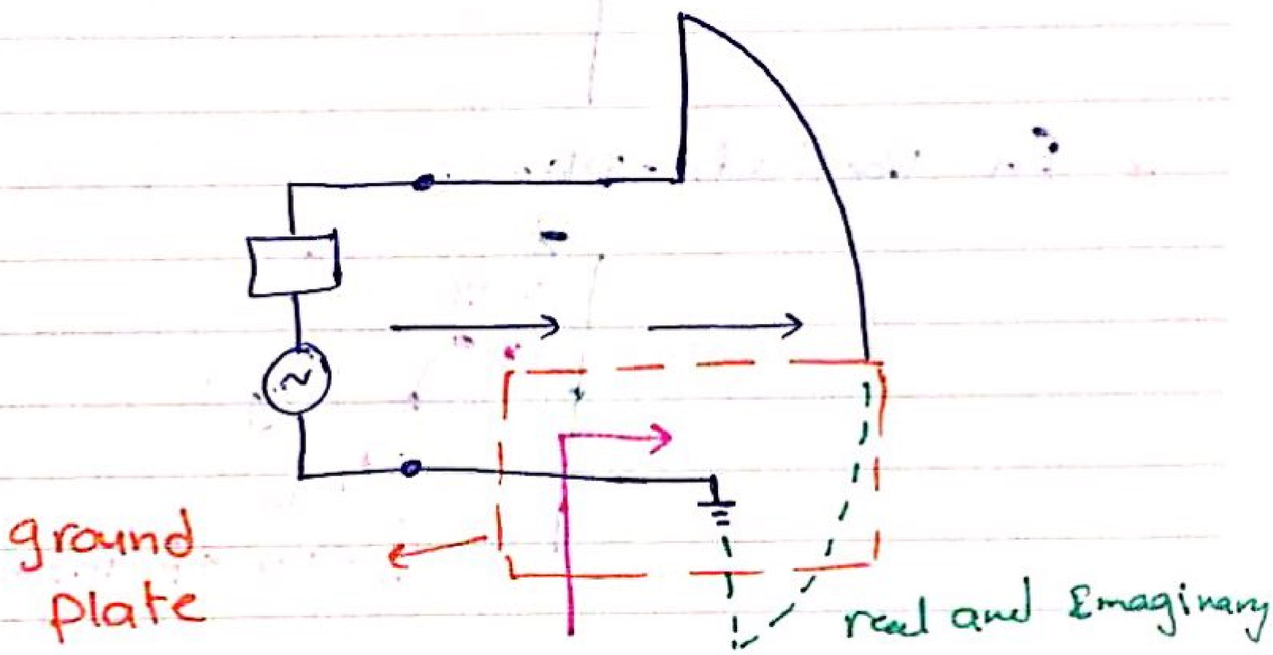
in 3D مقطع مساحته هاد.

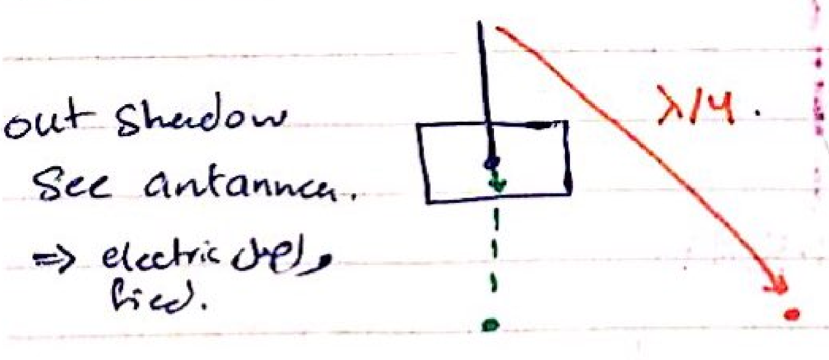


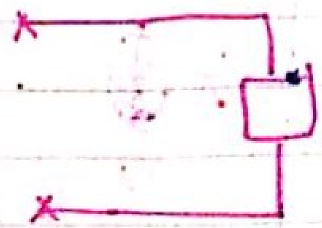
$$P_r = \frac{P_t \cdot G_{ant}}{4\pi r^2}$$ → free space equation for Tx, Rx power.

* أفضل اشي اقلل قيم Pt وازيد قيم Gant.

$T \alpha^{-1} G$





* 

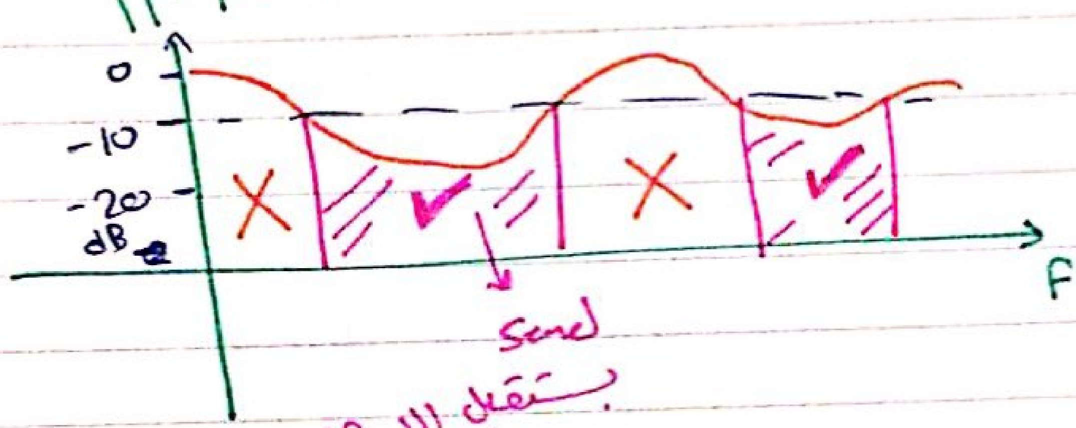
$Z_{ant} = a + jb$

a ↓ Tx power

jb ↓ stored energy

* If the antenna not match it will not radiate.

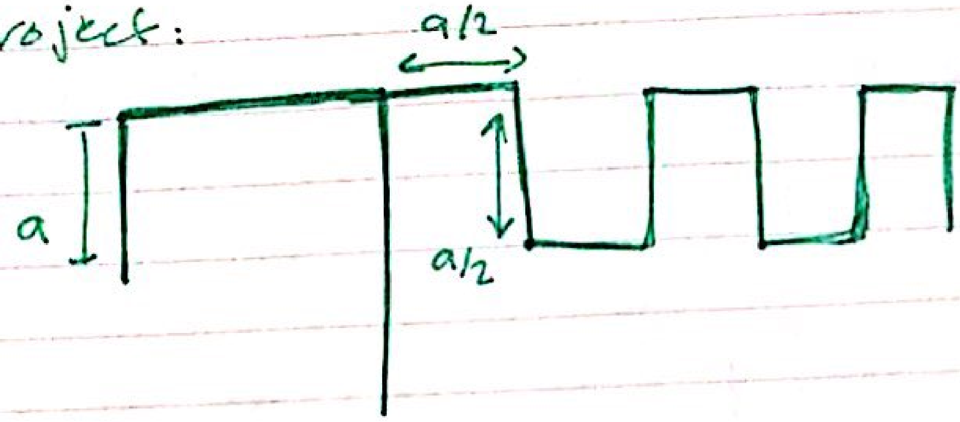
$|\Gamma| = S_{11}$ ((reflection coeff))



تبعثها .

22/8
TUE

project:



f = 2.4 GHz.

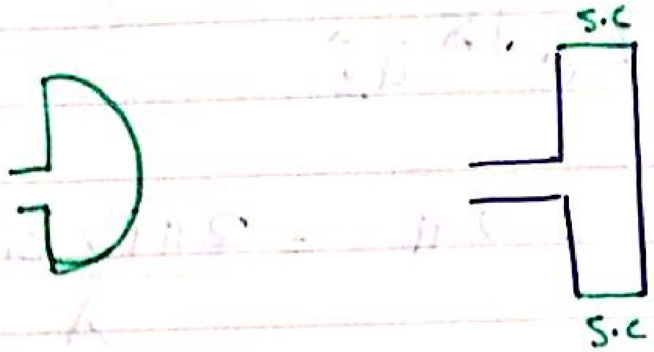
f = 3.75 GHz

S11

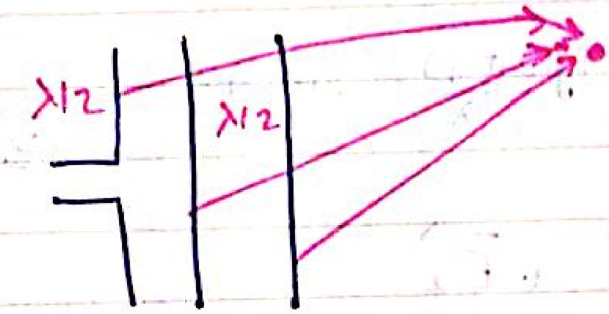
88

23/8/ Wed

$\lambda/2$ diapole → ابسط انواع الـ antenna



* لما يصيروا قراب ع بعض بصير بينهم Inductive و capacitance



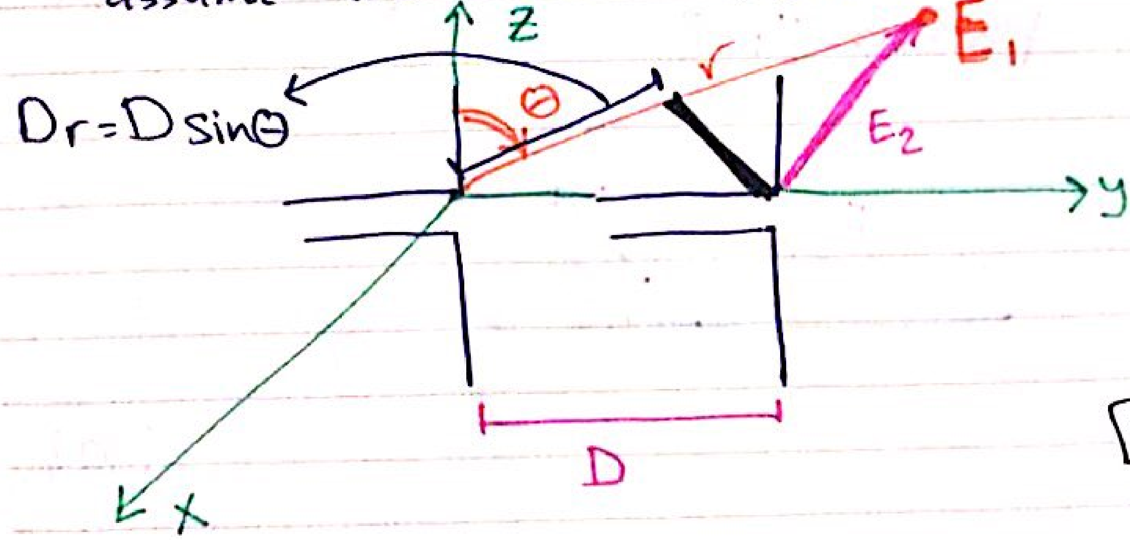
$E = \sum \vec{E_i}$

$E_i = E_o \angle \theta_i \ \vec{a_{ei}}$

$= E_o e^{j\theta_i} \ \vec{a_{ei}}$

* Antenna arays:-

assume we have 2 element.



$E_1 = E_0 \angle \theta \ \vec{a_z}$

$E_2 = E_0 \, e^{j\delta} \ \vec{a_z}$

$$\delta = \frac{\Delta r}{\lambda} * 2\pi = \frac{2\pi D \sin\theta}{\lambda}$$

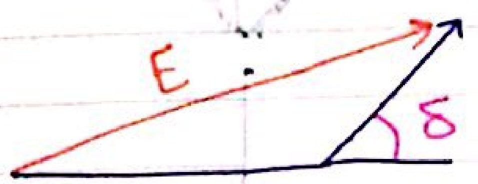
$$E_2 = E_0 \, e^{j \frac{2\pi D}{\lambda} \sin\theta} \ \vec{a_z}$$

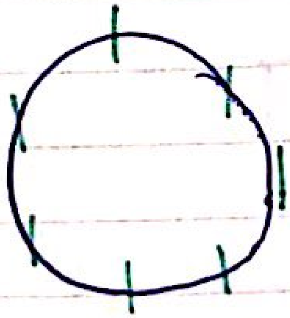
$$\vec{E} = \vec{E_1} + \vec{E_2}$$

$$= E_0 \left(1 + e^{j \frac{2\pi D}{\lambda} \sin\theta}\right) \vec{a_z}$$

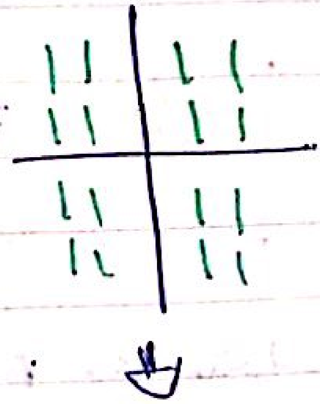
$$\vec{E} = \underbrace{\frac{A}{r} \sin\theta}_{\text{radiation pattern [RP]}} \underbrace{\left(1 + e^{j \frac{2\pi D}{\lambda} \sin\theta}\right)}_{\text{array factor [A.F)}} \vec{a_z}$$

radiation pattern [RP]   array factor [A.F)





circular array



Planer array

$$E = RP(x, y, z)\ AZ$$

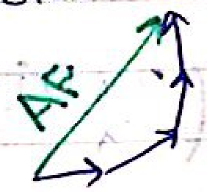
$$= \sum_{i=1}^{N} e^{j\delta_i}$$

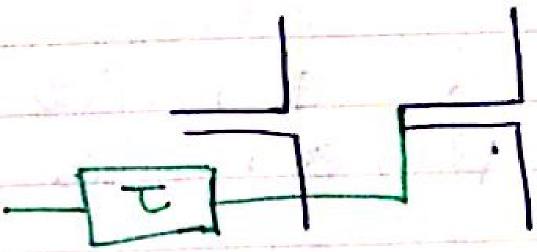
N = element عدد

dimentional space لا تعني

انا تعني عدد

* SUM of vector



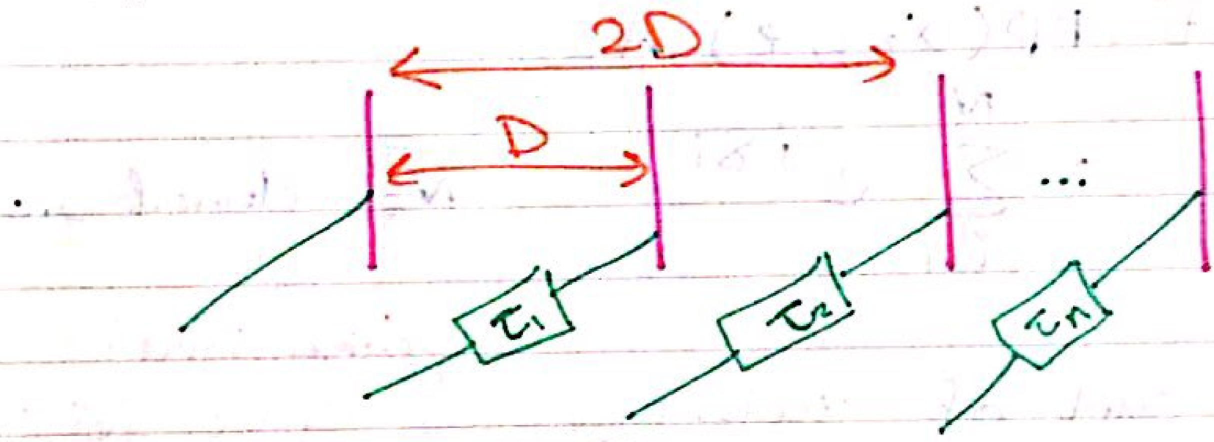


delay تأخير

$$E = E_0 \left(1 + e^{j\left(\frac{2\pi D}{\lambda}\sin\theta - \frac{\tau}{T} 2\pi\right)}\right) \vec{a_z}$$

$$\tau_i = \frac{i D T}{\lambda} \sin\theta$$

* لما اغير (τ) بغير ال radiation pattern ⇐ بتحرك
→ as a function of θ.



$$AF = \sum_{i=0}^{N-1} A\, e^{j\left(\frac{2\pi D i}{\lambda}\sin\theta - \frac{\tau_i}{T} 2\pi\right)}$$

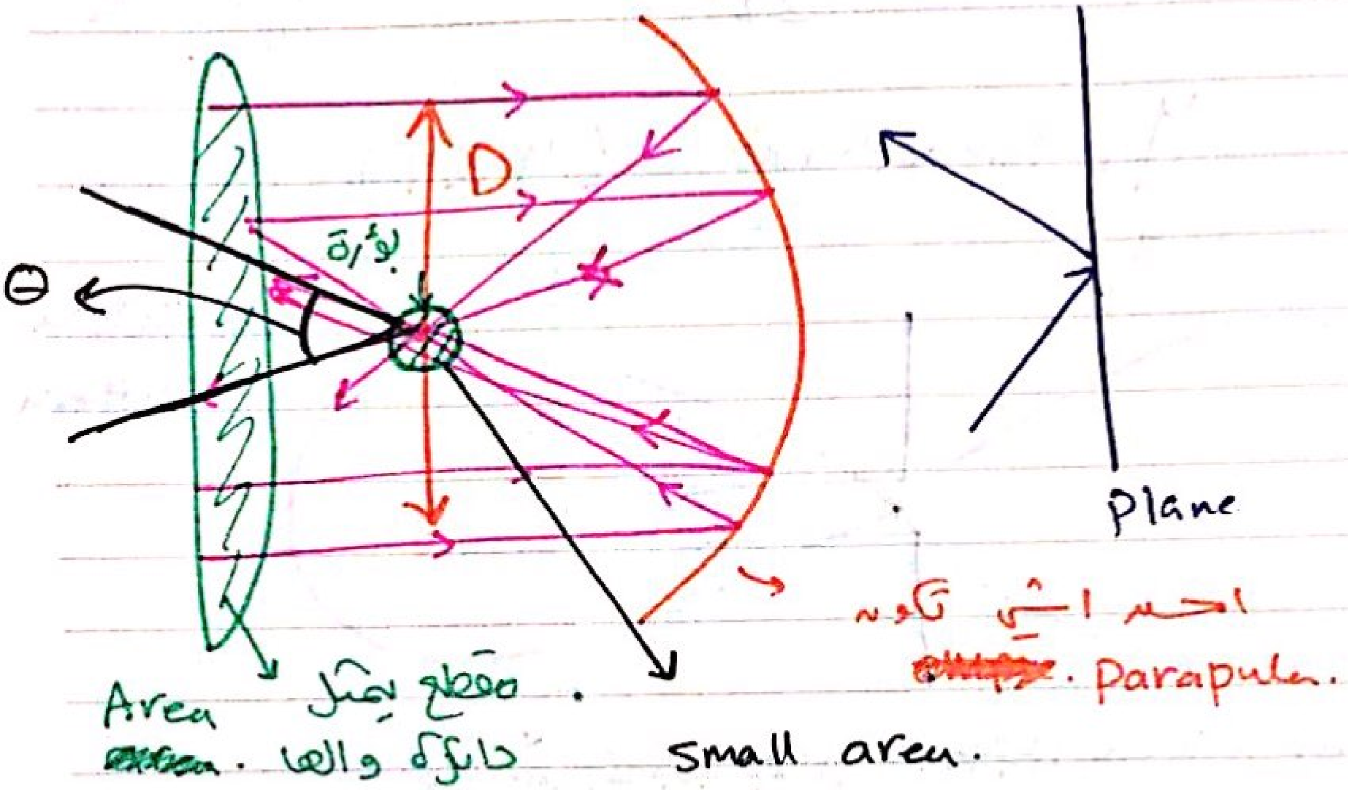
* in one dimension → بتحكم ب θ
* in space ⇒ بتحكم ب θ , β

→ AF at maximum

$$AF = NA$$

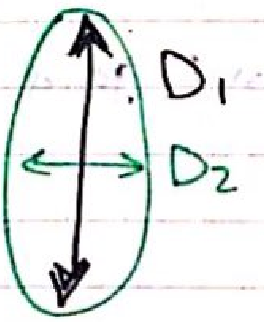
↑ Gain ↑ elements.

Reflector Antennas :-



$$G \propto \frac{Area}{area\,(small)}$$

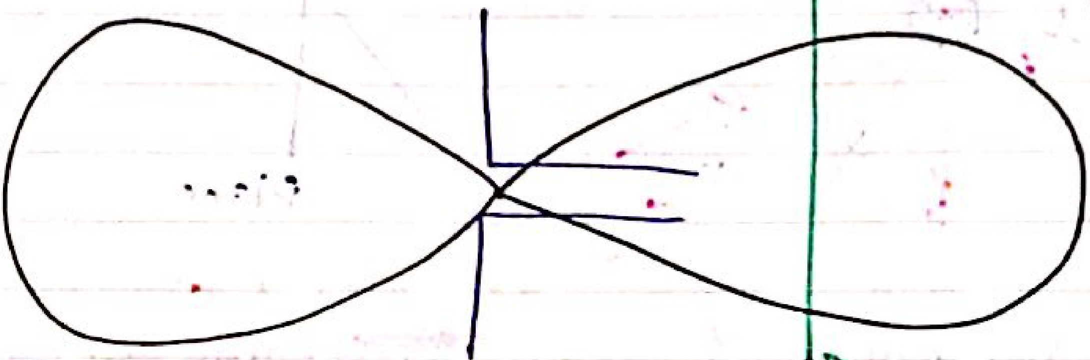
$$G = (D \cdot f)^2 \, \frac{16}{22^2}$$ ⇒ for circule



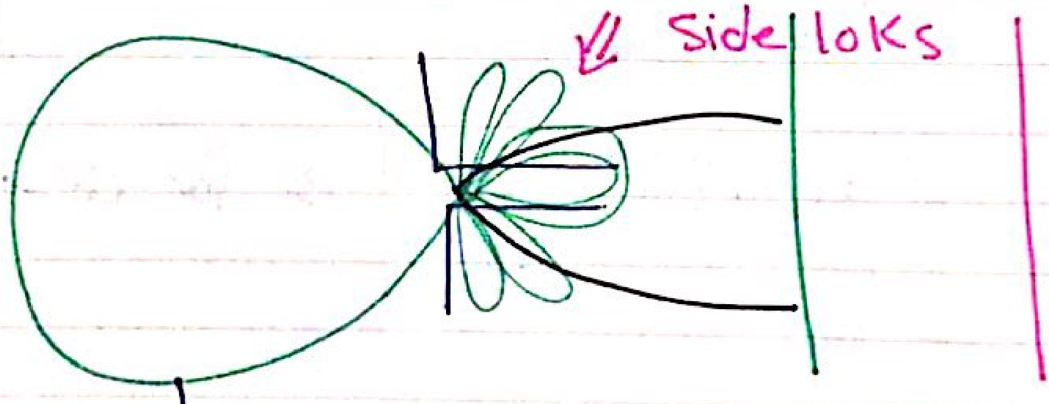
$$G = D_1 D_2 f^2 \cdot \frac{16}{22^2}$$ ⇒ لما تنعكس الاشارة عن البؤرة

$$G = D_1 D_2 f^2 \frac{16}{22^2} \gamma$$ ⇒ لما تنعكس عن البؤرة

γ ≡ Smoothness $(\gamma \leq 1)$



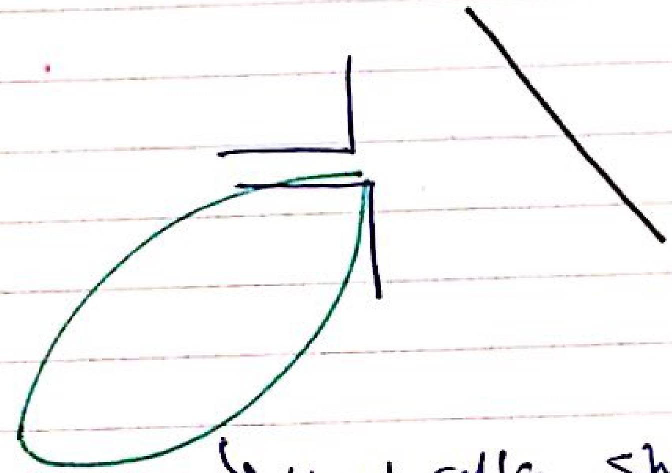
لوح من المعدن بعمل reflector عشان اي اشي بعد ما يوصلني.



→ الضخمة زادت gain

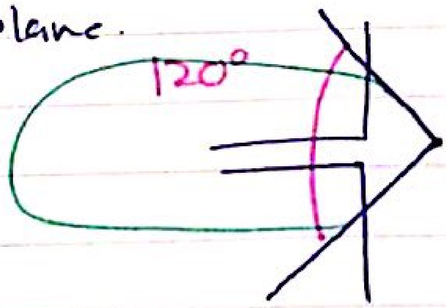
in array => antenna independent for each other.

* افضل اشي يكونو 2antenna فوق بعض عشان ~ ما تأثر كل وحدة عل التانية.



↳ umbrella shape use in cellular system.

In Horizontal plane.



"The END"