~ PART I ~

1. most general form:

① $\mathrm{rot}\,\vec{E} + \dfrac{\partial \vec{B}}{\partial t} = 0$

② $\mathrm{rot}\,\vec{H} - \dfrac{\partial \vec{D}}{\partial t} = \vec{J}_v + \sigma \vec{E}$

③ $\mathrm{div}\,\vec{D} = \rho$

④ $\mathrm{div}\,\vec{B} = 0$

simplest form: for complex domain, in simple medium

① $\mathrm{rot}\,\vec{E} - j\omega\mu\vec{H} = 0$

② $\mathrm{rot}\,\vec{H} + j\omega\varepsilon\vec{E} = \vec{J}_v + \sigma\vec{E}$

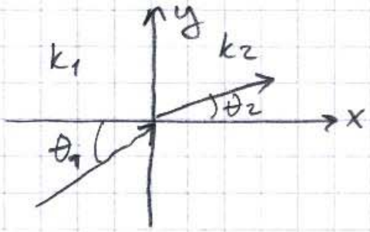
③ $\mathrm{div}\,\vec{E} = \rho/\varepsilon$

④ $\mathrm{div}\,\vec{H} = 0$

2. a) Brewster Angle: $\theta_B = \arctan\sqrt{\dfrac{\varepsilon_2}{\varepsilon_1}}$

b) Skin depth: $\delta = \sqrt{\dfrac{2}{\omega\mu\sigma}}$

c) Snell's Relation:



$\Rightarrow \boxed{k_1 . \sin\theta_1 = k_2 \sin\theta_2}$

3. a) $u(y,t) = e^{-y}\sin(3y + 6.10^8 t) = e^{-y}\cos(3y + 6.10^8 t - \frac{\pi}{2})$

$= e^{-y}\cos(-3y + \frac{\pi}{2} - 6.10^8 t) = \mathrm{Re}\left\{ e^{-y} . e^{i(-3y + \frac{\pi}{2} - 6.10^8 t)} \right\}$

$= \mathrm{Re}\left\{ \underbrace{e^{-y} . e^{-i3y} . \underbrace{e^{i\frac{\pi}{2}}}_{"i"}}_{u(y)} . \underbrace{e^{-i6.10^8 t}}_{e^{-i\omega t}} \right\}$

$\Rightarrow \boxed{u(y) = i . e^{-y} . e^{-i3y}} \quad \Rightarrow \quad \boxed{\vec{n} = -\vec{e}_y}$

b) $u(x,t) = \cos 2x . \sin 3t = \frac{1}{2}\left[\sin(2x + 3t) - \sin(2x - 3t)\right]$

$= \frac{1}{2}\left[\cos(2x + 3t - \frac{\pi}{2}) - \cos(2x - 3t - \frac{\pi}{2})\right]$

$= \frac{1}{2}\left\{\cos(-2x + \frac{\pi}{2} - 3t) - \cos(2x - \frac{\pi}{2} - 3t)\right]$

$$= Re\left\{ \frac{1}{2}\left[e^{-i2x} \cdot \underbrace{e^{i\frac{\pi}{2}}}_{=i} \cdot e^{-i3t} - e^{i2x} \cdot \underbrace{e^{-i\frac{\pi}{2}}}_{=-i} \cdot e^{-i3t} \right] \right\}$$

$$= Re\left\{ \underbrace{\frac{i}{2}\left(e^{-i2x} + e^{i2x} \right)}_{u(x)} \cdot \underbrace{e^{-i3t}}_{e^{-i\omega t}} \right\}$$

$$\boxed{u(x) = \frac{i}{2}\left(e^{-i2x} + e^{i2x} \right)} \Rightarrow \boxed{\vec{n}_- = -\vec{e}_x \ , \ \vec{n}_+ = \vec{e}_x}$$

(ters yönde ilerleyen iki dalga)

$$= i \cdot \cos(2x)$$

c) $u(x,y,z,t) = 3e^{-z} \cdot \cos(ax + by - \omega t)$

$$= Re\left\{ 3 \cdot e^{-z} \cdot e^{i(ax+by-\omega t)} \right\} = Re\left\{ \underbrace{3 \cdot e^{-z} \cdot e^{i(ax+by)}}_{u(x,y,z)} \cdot e^{-i\omega t} \right\}$$

$$\Rightarrow \boxed{u(x,y,z) = 3 \cdot e^{-z} \cdot e^{i(ax+by)}}$$

$$ax + by = k \cdot \vec{n} \cdot \vec{r} = \underbrace{(a\vec{e}_x + b\vec{e}_y)}_{k \cdot \vec{n}} \underbrace{(x\vec{e}_x + y\vec{e}_y)}_{\vec{r}}$$

$$\Rightarrow \boxed{\vec{n} = \frac{a\vec{e}_x + b\vec{e}_y}{\sqrt{a^2 + b^2}}}$$

4. $\vec{E}(x,y) = e^{i(5x+12y)} \cdot \vec{e}_z$

a) yukarıdaki ifade, $e^{ik\vec{n}\vec{r}}$ formunda yazılabildiğine göre düzlem dalgadır. Bu durumda,

$$k \cdot \vec{n} \cdot \vec{r} = \underbrace{(5\vec{e}_x + 12\vec{e}_y)}_{k \cdot \vec{n}} \cdot \underbrace{(x\vec{e}_x + y\vec{e}_y)}_{\vec{r}}$$

$$\Rightarrow \vec{n} = \frac{5\vec{e}_x + 12\vec{e}_y}{\sqrt{5^2 + 12^2}} \Rightarrow \boxed{\vec{n} = \frac{5}{13}\vec{e}_x + \frac{12}{13}\vec{e}_y}$$

b) $\boxed{k = 13}$

c) $\lambda = \frac{2\pi}{k} \Rightarrow \boxed{\lambda = \frac{2\pi}{13}}$

$\lambda \rightarrow$ dalga boyu

Boş uzayda dalganın faz hızı, ışık hızına eşit olacağından,

$$f = \frac{3.10^8}{\frac{2\pi}{13}} = \boxed{\frac{39}{2\pi}.10^8\,Hz = f}$$

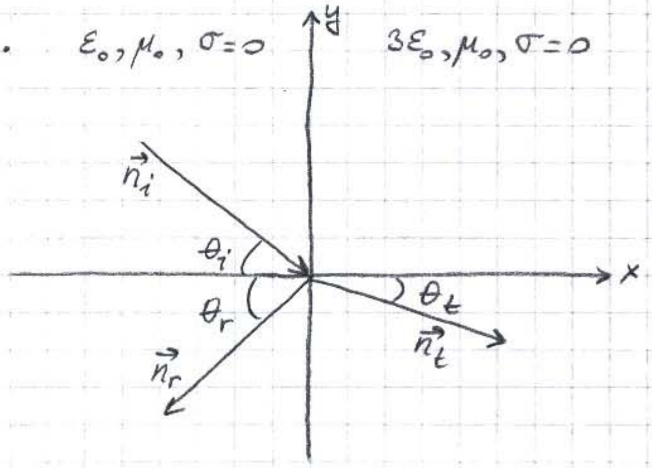
e) Düzlem dalga için,

$$\vec{H} = \frac{1}{Z_0}.\vec{n} \times \vec{E} = \frac{1}{Z_0}.\left(\frac{5}{13}\vec{e}_x + \frac{12}{13}\vec{e}_y\right) \times e^{i(5x+12y)}.\vec{e}_z$$

$$= \frac{1}{Z_0}.e^{i(5x+12y)}.\left(\frac{5}{13}\underbrace{\vec{e}_x \times \vec{e}_z}_{-\vec{e}_y} + \frac{12}{13}\underbrace{\vec{e}_y \times \vec{e}_z}_{\vec{e}_x}\right)$$

$$\Rightarrow \boxed{\vec{H} = \frac{1}{Z_0}.e^{i(5x+12y)}.\left(\frac{12}{13}\vec{e}_x - \frac{5}{13}\vec{e}_y\right)} \quad , \quad Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}} \cong 120\pi$$

1. $\varepsilon_0, \mu_0, \sigma = 0$ $\quad$ $3\varepsilon_0, \mu_0, \sigma = 0$



$$\vec{n}_i = \frac{1}{2}\vec{e}_x - \frac{\sqrt{3}}{2}\vec{e}_y$$
$$= \cos\theta_i \vec{e}_x - \sin\theta_i \vec{e}_y$$

$$\left.\begin{array}{l} \cos\theta_i = \frac{1}{2} \\ \sin\theta_i = \frac{\sqrt{3}}{2} \end{array}\right\} \Rightarrow \boxed{\theta_i = 60°}$$

$$\theta_r = \theta_i = 60°$$

a) Snell's law:

$$k_1 . \sin\theta_i = k_2 \sin\theta_t$$

$$\cancel{\omega}\sqrt{\cancel{\varepsilon_0\mu_0}} . \frac{\sqrt{3}}{2} = \cancel{\omega}\sqrt{3\cancel{\varepsilon_0\mu_0}} . \sin\theta_t \Rightarrow \sin\theta_t = \frac{1}{2} \Rightarrow \boxed{\theta_t = 30°}$$

propagation direction of the reflected wave:

$$\vec{n}_r = -\cos\theta_r \vec{e}_x - \sin\theta_r \vec{e}_y$$

$$\boxed{\vec{n}_r = -\frac{1}{2}\vec{e}_x - \frac{\sqrt{3}}{2}\vec{e}_y}$$

propagation direction of the transmitted wave:

$$\vec{n}_t = \cos\theta_t \vec{e}_x - \sin\theta_t \vec{e}_y$$

$$\boxed{\vec{n}_t = \frac{\sqrt{3}}{2}\vec{e}_x - \frac{1}{2}\vec{e}_y}$$

b) 1st Way:

incident field: $\vec{E} = \underset{\text{amplitude}}{1} . e^{ik_1 \vec{n}_i \vec{r}} . \vec{e}_z$

$$k_1 = \omega\sqrt{\varepsilon_0\mu_0} = 6.10^8 \sqrt{\frac{10^{-9}}{\cancel{36\pi}\,9} . 4\cancel{\pi} . 10^{-7}} = 6.10^8 . \frac{10^{-8}}{3} \Rightarrow \boxed{k_1 = 2}$$

$$\Rightarrow \vec{E}_i = e^{i\cdot 2\cdot\left(\frac{1}{2}\vec{e}_x - \frac{\sqrt{3}}{2}\vec{e}_y\right)\left(x\vec{e}_x + y\vec{e}_y\right)} \cdot \vec{e}_z$$

$$\boxed{\vec{E}_i = e^{i(x-\sqrt{3}y)} \cdot \vec{e}_z}$$

$Z_1 = \sqrt{\frac{\mu_0}{\varepsilon_0}} = Z_0$ (free space)

$$\vec{H}_i = \frac{1}{Z_0}\,\vec{n}_i \times \vec{E}_i = \frac{1}{Z_0}\left(\frac{1}{2}\vec{e}_x - \frac{\sqrt{3}}{2}\vec{e}_y\right) \times e^{i(x-\sqrt{3}y)}\vec{e}_z$$

$$= \frac{1}{Z_0}\cdot e^{i(x-\sqrt{3}y)}\left(\frac{1}{2}\vec{e}_x \times \vec{e}_z - \frac{\sqrt{3}}{2}\vec{e}_y \times \vec{e}_z\right)$$

$$\boxed{\vec{H}_i = \frac{1}{Z_0}\cdot e^{i(x-\sqrt{3}y)}\cdot\left(-\frac{\sqrt{3}}{2}\vec{e}_x - \frac{1}{2}\vec{e}_y\right)}$$

Components tangential to the interface:

$$\boxed{\begin{aligned} \vec{E}_{it} &= \vec{E}_i = e^{i(x-\sqrt{3}y)}\vec{e}_z \\ \vec{H}_{it} &= \frac{-1}{2Z_0}\cdot e^{i(x-\sqrt{3}y)}\cdot\vec{e}_y \end{aligned}}$$

Reflected field: $\vec{E}_r = A_1 \cdot e^{ik_1\vec{n}_r\vec{r}} \cdot \vec{e}_z$ $\qquad$ A_1: Reflection Coefficient

$$\vec{E}_r = A_1 \cdot e^{i(-x-\sqrt{3}y)} \cdot \vec{e}_z$$

$$\vec{H}_r = \frac{1}{Z_0}\,\vec{n}_r \times \vec{E}_r = \frac{1}{Z_0}\left(-\frac{1}{2}\vec{e}_x - \frac{\sqrt{3}}{2}\vec{e}_y\right) \times A_1 e^{i(-x-\sqrt{3}y)} \cdot \vec{e}_z$$

$$= \frac{A_1}{Z_0} e^{i(-x-\sqrt{3}y)}\left(-\frac{1}{2}\vec{e}_x \times \vec{e}_z - \frac{\sqrt{3}}{2}\vec{e}_y \times \vec{e}_z\right)$$

$$\vec{H}_r = \frac{A_1}{Z_0} e^{i(-x-\sqrt{3}y)}\left(-\frac{\sqrt{3}}{2}\vec{e}_x + \frac{1}{2}\vec{e}_y\right)$$

tangential Components:

$$\boxed{\begin{aligned} \vec{E}_{rt} &= \vec{E}_r = A_1 \cdot e^{i(-x-\sqrt{3}y)} \cdot \vec{e}_z \\ \vec{H}_{rt} &= \frac{A_1}{2Z_0} e^{i(-x-\sqrt{3}y)} \cdot \vec{e}_y \end{aligned}}$$

transmitted field: $\vec{E}_t = A_2 \cdot e^{ik_2 \vec{n}_t \vec{r}} \cdot \vec{e}_z$

$$k_2 = \omega\sqrt{3\varepsilon_0\mu_0} = k_1 \cdot \sqrt{3} = \underline{\underline{2\sqrt{3}}}$$

$$\Rightarrow \vec{E}_t = A_2 \cdot e^{i \cdot 2\sqrt{3}\left(\frac{\sqrt{3}}{2}\vec{e}_x - \frac{1}{2}\vec{e}_y\right)(x\vec{e}_x + y\vec{e}_y)} \cdot \vec{e}_z$$

$$\Rightarrow \boxed{\vec{E}_t = A_2 \cdot e^{i(3x - \sqrt{3}y)} \cdot \vec{e}_z}$$

$$z_2 = \sqrt{\frac{\mu_0}{3\varepsilon_0}} = \frac{z_0}{\sqrt{3}}$$

$$\Rightarrow \vec{H}_t = \frac{1}{z_2}\vec{n}_t \times \vec{E}_t = \frac{\sqrt{3}}{z_0}\left(\frac{\sqrt{3}}{2}\vec{e}_x - \frac{1}{2}\vec{e}_y\right) \times A_2 \cdot e^{i(3x - \sqrt{3}y)} \cdot \vec{e}_z$$

$$= \frac{\sqrt{3}}{z_0}A_2 \cdot e^{i(3x - \sqrt{3}y)} \cdot \left(\frac{\sqrt{3}}{2}\vec{e}_x \times \vec{e}_z - \frac{1}{2}\vec{e}_y \times \vec{e}_z\right)$$

$$\boxed{\vec{H}_t = \frac{\sqrt{3}}{z_0}A_2 \cdot e^{i(3x - \sqrt{3}y)} \cdot \left(-\frac{1}{2}\vec{e}_x - \frac{\sqrt{3}}{2}\vec{e}_y\right)}$$

Components tangential to the interface:

$$\vec{E}_{tt} = \vec{E}_t = A_2 \cdot e^{i(3x - \sqrt{3}y)} \vec{e}_z$$

$$\vec{H}_{tt} = -\frac{3A_2}{2z_0} \cdot e^{i(3x - \sqrt{3}y)} \cdot \vec{e}_y$$

Tam yüzey üzerinde yani $x=0$'da, yüzeyin solunda ve sağında kalan alanların teğet bileşenlerinin toplamı eşit olmalı.

Elektrik alanı için:

$$\vec{E}_{it} + \vec{E}_{rt} = \vec{E}_{tt}$$

$$e^{i(x - \sqrt{3}y)} \cdot \cancel{\vec{e}_z} + A_1 \cdot e^{i(-x - \sqrt{3}y)} \cdot \cancel{\vec{e}_z} \Big|_{x=0} = A_2 \cdot e^{i(3x - \sqrt{3}y)} \cdot \cancel{\vec{e}_z} \Big|_{x=0}$$

$$\Rightarrow \cancel{e^{-i\sqrt{3}y}} + A_1 \cdot \cancel{e^{-\sqrt{3}y}} = A_2 \cdot \cancel{e^{-\sqrt{3}y}}$$

$$\Rightarrow \boxed{1 + A_1 = A_2} \quad (1)$$

Manyetik alan için:

$$\vec{H}_{it} + \vec{H}_{rt} = \vec{H}_{tt}$$

$$-\frac{1}{2Z_0} \cdot e^{i(x-\sqrt{3}y)} \cdot \vec{e_y} + \frac{A_1}{2Z_0} \cdot e^{i(-x-\sqrt{3}y)} \cdot \vec{e_y} \Big|_{x=0} = -\frac{3A_2}{2Z_0} \cdot e^{i(3x-\sqrt{3}y)} \cdot \vec{e_y} \Big|_{x=0}$$

$$\Rightarrow -\frac{1}{\cancel{2Z_0}} \cdot e^{-i\sqrt{3}y} \cdot \cancel{\vec{e_y}} + \frac{A_1}{\cancel{2Z_0}} \cdot e^{-i\sqrt{3}y} \cdot \cancel{\vec{e_y}} = \frac{-3A_2}{\cancel{2Z_0}} \cdot e^{-i\sqrt{3}y} \cdot \cancel{\vec{e_y}}$$

$$\Rightarrow \boxed{-1 + A_1 = -3A_2} \; (2)$$

(1) ve (2) denklemlerinden,

$$A_2 = A_1 + 1 \Rightarrow -1 + A_1 = -3(A_1+1) \Rightarrow -1 + A_1 = -3A_1 - 3$$

$$\Rightarrow 4A_1 = -2$$

$$\Rightarrow \boxed{A_1 = \frac{-1}{2}} \quad \Rightarrow A_2 = 1 - \frac{1}{2} = \boxed{\frac{1}{2} = A_2}$$

2nd Way:

$$A_1 = \frac{Z_2\cos\theta_i - Z_0\cos\theta_t}{Z_2\cos\theta_i + Z_0\cos\theta_t} \qquad Z_2 = \sqrt{\frac{\mu_0}{3\varepsilon_0}} = \frac{Z_0}{\sqrt{3}}, \quad \theta_i = 60^\circ, \theta_t = 30^\circ$$

$$A_1 = \frac{\frac{Z_0}{\sqrt{3}} \cdot \frac{1}{2} - Z_0 \cdot \frac{\sqrt{3}}{2}}{\frac{Z_0}{\sqrt{3}} \cdot \frac{1}{2} + Z_0 \cdot \frac{\sqrt{3}}{2}} = \frac{\cancel{Z_0}\left(\frac{1-3}{\cancel{2\sqrt{3}}}\right)}{\cancel{Z_0}\left(\frac{1+3}{\cancel{2\sqrt{3}}}\right)} = \frac{-2}{4} \Rightarrow \boxed{A_1 = \frac{-1}{2}}$$

$$A_2 = 1 + A_1 = 1 - \frac{1}{2} \Rightarrow \boxed{A_2 = \frac{1}{2}}$$

c) Magnetic field vector of the transmitted wave:

$$\vec{H}_t = \frac{\sqrt{3}}{Z_0} \cdot A_2 \cdot e^{i(3x-\sqrt{3}y)} \cdot \left(-\frac{1}{2}\vec{e}_x - \frac{\sqrt{3}}{2}\vec{e_y}\right)$$

$$\Rightarrow \boxed{\vec{H}_t = \frac{\sqrt{3}}{2Z_0} \cdot e^{i(3x-\sqrt{3}y)} \left(-\frac{1}{2}\vec{e}_x - \frac{\sqrt{3}}{2}\vec{e_y}\right)}$$

2. $\vec{H}(x,y) = (1+i).e^{i\pi[(2+i)x+2y]}.(A\vec{e_x}+\vec{e_y})$

First, we need to reorganize the expression of $\vec{H}$.

$$\vec{H}(x,y) = (1+i).e^{i2\pi x}.e^{-\pi x}.e^{i2\pi y}.(A\vec{e_x}+\vec{e_y})$$

$$\Rightarrow \boxed{\vec{H}(x,y) = (1+i).e^{-\pi x}.e^{i2\pi(x+y)}.(A.\vec{e_x}+\vec{e_y})}$$

a) It must satisfy: $div\vec{H} = 0$

$$div\vec{H} = \frac{\partial}{\partial x}H_x + \frac{\partial}{\partial y}H_y + \cancel{\frac{\partial}{\partial z}H_z}^{0} = 0$$

$$= \frac{\partial}{\partial x}\left[(1+i)e^{-\pi x}.e^{i2\pi(x+y)}.A\right] + \frac{\partial}{\partial y}\left[(1+i).e^{-\pi x}.e^{i2\pi(x+y)}\right]$$

$$= (1+i).A.(-\pi+i2\pi).e^{-\pi x}.e^{i2\pi(x+y)} + (1+i).i2\pi.e^{-\pi x}.e^{i2\pi(x+y)}$$

$$= (1+i).e^{-\pi x}.e^{i2\pi(x+y)}.\underbrace{[A.(-\pi+i2\pi)+i2\pi]}_{=0} = 0$$

$$\Rightarrow A = \frac{-i2\cancel{\pi}}{\cancel{\pi}(-1+2i)} \quad (-1-2i) \Rightarrow \boxed{A = \frac{-4+2i}{5}}$$

b) Since it can be written in the form $H_0.e^{-\beta x}.e^{i\alpha\vec{n}\vec{r}}$, where

$k = \alpha + i\beta$, α: phase constant

β: attenuation constant

$$e^{i\alpha\vec{n}\vec{r}} = e^{i2\pi(x+y)} = e^{i(2\pi x+2\pi y)} = e^{i(2\pi\vec{e_x}+2\pi\vec{e_y})(x\vec{e_x}+y\vec{e_y})}$$

$$\Rightarrow \alpha\vec{n} = 2\pi\vec{e_x}+2\pi\vec{e_y}$$

$$\Rightarrow \vec{n} = \frac{2\pi\vec{e_x}+2\pi\vec{e_y}}{\underbrace{\sqrt{(2\pi)^2+(2\pi)^2}}_{\alpha}} = \frac{\cancel{2\pi}(\vec{e_x}+\vec{e_y})}{\cancel{2\pi}\sqrt{2}} \Rightarrow \boxed{\vec{n} = \frac{1}{2}\vec{e_x}+\frac{1}{2}\vec{e_y}}$$

$$\Rightarrow \alpha = 2\sqrt{2}\pi \ , \quad \beta = \pi \quad \Rightarrow \quad k = 2\sqrt{2}\pi + i\pi$$

$$k^2 = (2\sqrt{2}\pi + i\pi)^2 = \omega^2 \varepsilon \mu + i\omega\sigma\mu$$

$$8\pi^2 + i4\sqrt{2}\pi^2 - \pi^2 = 7\pi^2 + i4\sqrt{2}\pi^2 = \omega^2\varepsilon\mu + i\omega\sigma\mu \quad (*)$$

$$\Rightarrow \omega^2 \varepsilon \mu = 7\pi^2$$

$$\omega^2 . \cancel{7} . \frac{10^{-9}}{\cancel{36\pi}\,9} . \cancel{4\pi}.10^{-7} = \cancel{7}\pi^2 \quad \Rightarrow \omega^2 = 9\pi^2 . 10^{16}$$

$$\Rightarrow \omega = 3\pi . 10^8 = 2\pi f$$

$$\Rightarrow f = 1{,}5 . 10^8 \, Hz \Rightarrow \boxed{f = 150 \, MHz}$$

For $\vec{H}(x,y,t)$, let's reorganize $\vec{H}(x,y)$ again.

$$\vec{H}(x,y) = (1+i) . e^{-\pi x} . e^{i2\pi(x+y)} . \left[\left(\frac{-4+2i}{5} \right) \vec{e_x} + \vec{e_y} \right]$$

$$\vec{H}(x,y) = \sqrt{2} \underbrace{\left(\frac{1}{\sqrt{2}} + i\frac{1}{\sqrt{2}} \right)}_{e^{i45^\circ}} . e^{-\pi x} . e^{i2\pi(x+y)} . \left[\frac{2}{\sqrt{5}} \underbrace{\left(\frac{-2}{\sqrt{5}} + i\frac{1}{\sqrt{5}} \right)}_{e^{i\theta}} \vec{e_x} + \vec{e_y} \right]$$

$$\left. \begin{aligned} \cos\theta &= \frac{-2}{\sqrt{5}} \\ \sin\theta &= \frac{1}{\sqrt{5}} \end{aligned} \right\} \Rightarrow \theta \cong 153^\circ$$

$$= \frac{2\sqrt{2}}{\sqrt{5}} . e^{-\pi x} . e^{i45^\circ} . e^{i153^\circ} . e^{i2\pi(x+y)} . \vec{e_x} + \sqrt{2} . e^{-\pi x} . e^{i45^\circ} . e^{i2\pi(x+y)} . \vec{e_y}$$

$$\vec{H}(x,y,t) = Re \left\{ \left(\frac{2\sqrt{2}}{\sqrt{5}} . e^{-\pi x} . e^{i[2\pi(x+y)+198^\circ]} . \vec{e_x} + \sqrt{2} . e^{-\pi x} . e^{i[2\pi(x+y)+45^\circ]} . \vec{e_y} \right) . e^{-i3\pi.10^8 t} \right.$$

$$= Re \left\{ \frac{2\sqrt{2}}{\sqrt{5}} e^{-\pi x} . e^{i[2\pi(x+y)+198^\circ]} . e^{-i3\pi.10^8 t} . \vec{e_x} + \sqrt{2} . e^{-\pi x} . e^{i[2\pi(x+y)+45^\circ]} . e^{-i3\pi.10^8 t} . \vec{e_y} \right.$$

$$= Re \left\{ \sqrt{2} e^{-\pi x} \left(\frac{2}{\sqrt{5}} e^{i[2\pi(x+y)+198^\circ - 3\pi.10^8 t]} \vec{e_x} + e^{i[2\pi(x+y)+45^\circ - 3\pi 10^8 t]} . \vec{e_y} \right) \right\}$$

$$\boxed{\vec{H}(x,y,t) = \sqrt{2} . e^{-\pi x} \left(\frac{2}{\sqrt{5}} \cos[2\pi(x+y) - 3\pi.10^8 t + 198^\circ] \vec{e_x} + \cos[2\pi(x+y) - 3\pi.10^8 t + 45^\circ] \right)}$$

c) from the equation (*),

$$\omega \sigma \mu = 4\sqrt{2}\pi^2 \Rightarrow \sigma = \frac{4\sqrt{2}\pi^2}{\omega \mu}$$

$$\sigma = \frac{\cancel{4}\sqrt{2}\cancel{\pi^2}}{3\cancel{\pi}\cdot 10^8 \cdot \cancel{4}\cancel{\pi}\cdot 10^{-7}} \Rightarrow \boxed{\sigma = \frac{\sqrt{2}}{30}}$$