5.1.1 SOLUTION:

$$\vec{E} = f(t - z/C_0)\cdot\hat{x} = \exp\left[-(t - z/C_0)^2/\tau^2\right]\cdot\exp\left[j\cdot 2\pi\nu_0(t - z/C_0)\right]\cdot\hat{x} = E_x\cdot\hat{x}$$

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

$$\nabla\times\vec{E} = \begin{bmatrix} \hat{x} & \hat{y} & \hat{z} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ E_x & E_y & E_z \end{bmatrix} = \frac{\partial E_x}{\partial z}\cdot\hat{y} - \frac{\partial E_x}{\partial y}\cdot\hat{z}$$

$$= \frac{\partial E_x}{\partial z}\cdot\hat{y}$$

$$= E_x\left[\frac{2(t - z/C_0)^2}{\tau^2 C_0} - \frac{j2\pi\nu_0}{C_0}\right]\hat{y}$$

So, $$\frac{\partial\vec{B}}{\partial t} = -\nabla\times\vec{E} = -E_x\left[\frac{2(t - z/C_0)^2}{\tau^2 C_0} - \frac{j2\pi\nu_0}{C_0}\right]\hat{y}$$

$$\vec{B} = -\int E_x\left[\frac{2(t - z/C_0)^2}{\tau^2 C_0} - \frac{j2\pi\nu_0}{C_0}\right]\cdot dt\cdot\hat{y}$$

Where $E_x = \exp\left[-(t - z/C_0)^2/\tau^2\right]\cdot\exp\left[j\cdot 2\pi\nu_0(t - z/C_0)\right]\cdot\hat{x}$

Therefore, we can find the wave travels along the $\hat{z}$ direction, and the Electrical field is decaying.

5.3.1 (a) $\vec{E}(\vec{r}) = E_0 \cdot \sin\beta y \cdot \exp(-j\beta z)\cdot \hat{x}$

$$= E_0\left[\frac{1}{2j}(e^{j\beta y} - e^{-j\beta y})\right]\cdot \exp(-j\beta z)\cdot\hat{x}$$

$$= \frac{E_0}{2j}\left[e^{-j\beta(z-y)} - e^{-j\beta(z+y)}\right]\cdot\hat{x}$$

So, $\beta\sqrt{2} = \frac{2\pi}{\lambda_0} \Rightarrow \beta = \frac{\sqrt{2}\cdot\pi}{\lambda_0}$

(b) $\nabla\times\vec{E} = -j\omega\mu_0\cdot\vec{H}$

So, we can get $\vec{H} = \frac{1}{-j\omega\mu_0}\cdot\nabla\times\vec{E}$

$$= \frac{1}{-j\omega\mu_0}\left[\frac{\partial E_x}{\partial z}\cdot\hat{y} - \frac{\partial E_x}{\partial y}\hat{z}\right]$$

$$= \frac{1}{-j\omega\mu_0}\left[(-j\beta)\cdot E_0\cdot\sin\beta y\cdot\exp(-j\beta z)\cdot\hat{y} - \beta E_0\cos\beta y\cdot\exp(-j\beta z)\hat{z}\right]$$

$$= \frac{\beta E_0\sin\beta y\cdot\exp(-j\beta z)}{\omega\mu_0}\cdot\hat{y} - j\frac{\beta E_0\cdot\cos\beta y\cdot\exp(-j\beta z)}{\omega\mu_0}\cdot\hat{z}$$

(c) $\vec{S} = \frac{1}{2}\vec{E}\times\vec{H}^* = \frac{\beta E_0^2\cdot\sin^2\beta y\cdot}{2\omega\mu_0}\cdot\hat{z} - j\frac{\beta E_0^2\cdot\sin\beta y\cdot\cos\beta y}{\omega\mu_0}\cdot\hat{y}$

the direction of flow of optical power is along $\hat{z}$ direction and along $\hat{y}$ direction, ~~and the phase difference between them is 90°~~.

And because the optical intensity is the magnitude of the vector $Re\{\vec{S}\}$.
So, the direction is along the $\hat{z}$ direction, and the average optical power flowing along the y direction is zero.

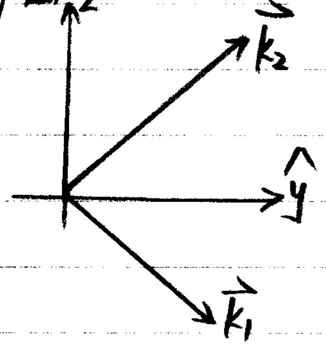
(d) Because $\vec{E}(\vec{r}) = \left[\frac{E_0}{2j} \cdot e^{-j\beta(z-y)} + \frac{E_0 j}{2} \cdot e^{-j\beta(z+y)}\right] \cdot \hat{x} = E_1 \cdot \hat{x} + E_2 \cdot \hat{x}$

where $E_1 = \frac{E_0}{2j} \cdot e^{-j\beta(z-y)}$ so, $\vec{k_1} = \beta \cdot \hat{z} - \beta \cdot \hat{y}$

$E_2 = \frac{E_0 j}{2} \cdot e^{-j\beta(z+y)}$ so, $\vec{k_2} = \beta \cdot \hat{z} + \beta \cdot \hat{y}$

So, the direction of propagation of E_1, H_1 is .

the direction of propagation of E_2: $\hat{z}$



5.4.1 a) $I = P/A = 1/10^{-8} = 10^{8}\ w/m^2$, $\eta_0 = \left(\frac{\mu_0}{\varepsilon_0}\right)^{1/2} = 120\pi$

$I = \frac{|E_0|^2}{2\eta} \Rightarrow E_0 = \sqrt{2\eta I} = 2.746 \times 10^{5}\ v/m$

(b) $I_0 = \frac{2P}{\pi W_0^2} = \frac{2}{\pi \times 10^{-8}} = \frac{2}{\pi} \times 10^{8}$

$E_0 = \sqrt{2\eta I} = \sqrt{480 \times 10^{8}} = 2.191 \times 10^{5}\ v/m$