المحاضرة الثامنة

*4.3 poynting vector for elliptically or circularly polarized wave:

متجه بوينتك لموجات مستقطبة بيضوية ودائرية الشكل

- The complex poynting vector is
- متجه بوينتك : المعدل الزمني في الطاقة الكهرومغناطيسية المخزونة في حجم ثابت أو المعدل الزمني للطاقة المتدفقة في وحدة المساحة .

  $\dot{S} = \frac{1}{2}\, \dot{E} \times H^*$ ------------ (1)

  Where H^* is collected the complex conjugate of H المرافق المعقد
- The average poynting vector is the real part of (1) , or

  $S_{av} = Re\, \dot{s} = \frac{1}{2}\, Re\, \dot{E} \times H^*$ ----------- (2)
- In a lossless medium (electric and magnetic field in time phase) (طور الزمن).
- But

  $\frac{E_1}{H_1} = \frac{E_2}{H_2} = Z$

  Where Z the intrinsic impedance الممانعة الذاتية of the medium is read so

$\times \frac{H_1}{H_1}$ $\times \frac{H_2}{H_2}$

↑ ↑

$$S_{av} = \frac{1}{2}\, \hat{Z}\, (E_1 H_1 + E_2 H_2)$$ ----------- **(3)**

$\hat{Z}$ **is the unit vector in the Z direction .**

$$S_{av} = \frac{1}{2}\, \hat{Z}\, \left(\frac{E_1 H_1 H_1}{H_1} + \frac{E_2 H_2 H_2}{H_2} \right)$$

$$S_{av} = \frac{1}{2}\, \hat{Z}\, (H_1^2 + H_2^2) Z$$ ---------- **(4)**

Where H = $\sqrt{H_1^2 + H_2^2}$

The eq^n (4) becomes

$$S_{av} = \frac{1}{2}\,\hat{Z}\,H^2 Z \text{ ------------ (5)}$$

$$S_{av} = \frac{1}{2}\,\hat{Z}\,\left(\frac{E_1 E_1 H_1}{E_1} + \frac{E_2 E_2 H_2}{E_2}\right)$$

$$S_{av} = \frac{1}{2}\,\hat{Z}\,\left(\frac{E_1^2}{Z} + \frac{E_2^2}{Z}\right) = \frac{1}{2}\,\hat{Z}\,\left(\frac{E_1^2 + E_2^2}{Z}\right) \text{ ----------- (6)}$$

But $E = \sqrt{E_1^2 + E_2^2}$

eq^n (5) becomes

$$S_{av} = \frac{1}{2}\,\hat{Z}\,\frac{E^2}{Z} \text{ ------------ (7)}$$

Ex/ An elliptically polarized wave traveling in the positive (Z) direction in air has (X) and (Y) components.

$$E_x = 3\sin(\omega t - BZ)\ (Vm^{-1})$$

$$E_y = 6\sin(\omega t - BZ + 75^0)\ (Vm^{-1})$$

Find the average power per unit area conveyed (الحالة) by the wave.

Sol. / $\boldsymbol{S_{av}} = \frac{1}{2}\hat{Z}\frac{E^2}{Z}$

$= \frac{1}{2}\frac{E_1^2 + E_2^2}{Z}$

E_1 =3 (Vm^{-1})

E_2 = 6 (Vm^{-1})

Z = 376.7 Ω for air

$$\boldsymbol{S_{av}} = \frac{1}{2}\frac{3^2 + 6^2}{376.7} = \frac{1}{2}\frac{45}{376.7} \approx 60\ mwm^{-2}$$