$f(z)$ analytic

$$\sin z = \sin(x+jy) = \sin x \underbrace{\cos(jy)}_{} + \cos x \underbrace{\sin(jy)}_{}$$

$$\frac{e^{jjy}+e^{-jjy}}{2} = \cosh y$$

$$\frac{e^{jjy}-e^{-jjy}}{2j} = j\sinh y$$

$$= \underbrace{\sin x \cosh y}_{u} + j\underbrace{\cos x \sinh y}_{v}$$

$$\frac{\partial u}{\partial x} = \cos x \cosh y$$

$$\frac{\partial u}{\partial y} = \sin x \sinh y$$

$$\frac{\partial v}{\partial x} = -\sin x \sinh y$$

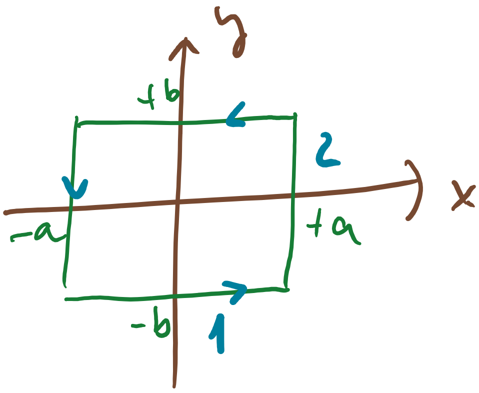
$$\frac{\partial v}{\partial y} = \cos x \cosh y$$

$$\frac{\partial}{\partial y}\cosh y = \frac{\partial}{\partial x}\frac{e^{y}+e^{-y}}{2}$$

$$= \sinh y$$

$$\frac{\partial}{\partial y}\sinh y = \frac{\partial}{\partial y}\frac{e^{y}-e^{-y}}{2}$$

$$= \cosh y$$



$z = x + jy$

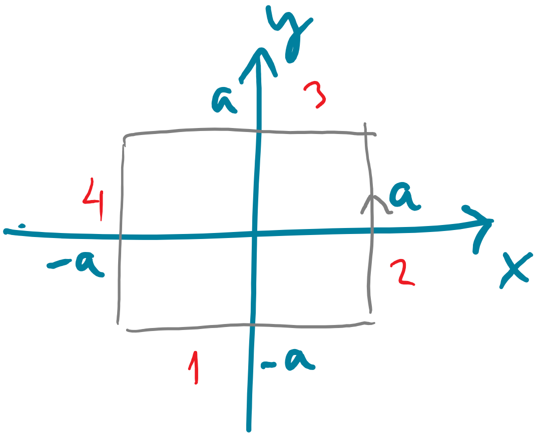
1: $\displaystyle\int_{-a}^{+a} (x - jb)\,dx = -2jab$

2: $\displaystyle\int_{-b}^{b} (a + jy)\,j\,dy = 2jab$

3: $\displaystyle\int_{+a}^{-a} (x + jb)\,dx = -2jab$

4: $\displaystyle\int_{+b}^{-b} (-a + jy)\,j\,dy = +2jab$

$\displaystyle\oint_{\square} z\,dz = 0$



$$f(z) = \frac{1}{z}$$

$$1: \int_{-a}^{a} \frac{1}{x - ja}\, dx$$

$$= \Big/_{-a}^{a} \ln(x - ja) = \ln \frac{a - ja}{-a - ja}$$

$$= \ln \frac{\cancel{\sqrt{2}a}\, e^{-j\pi/4}}{\cancel{\sqrt{2}a}\, e^{-j3\pi/4}} = \ln e^{j\pi/2}$$

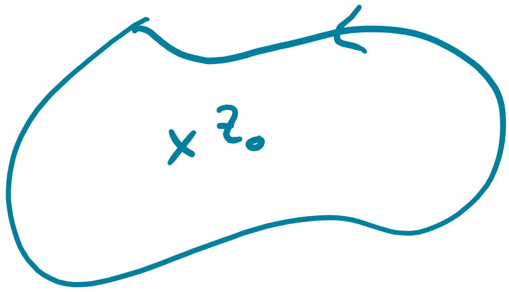
$$= j\pi/2$$

$$2: \int_{-a}^{a} \frac{1}{a + jy}\, j\, dy$$

$$= j \Big/_{-a}^{a} \ln(a + jy) \frac{1}{j} = \ln \frac{a + ja}{a - ja} \nearrow$$

$$\int_{-a}^{a} \frac{1}{-ja + y}\, dy$$

$$\oint_{\square} \frac{1}{z}\, dz = 4 \cdot j \frac{\pi}{2} = 2\pi j$$



$$\oint \frac{f(z)}{z - z_0}\, dz = 2\pi j f(z_0)$$

$$\bar{\bar{A}} : \bar{a}\bar{b} = 0 \qquad \forall \bar{a}, \bar{b}$$

$$\Rightarrow \bar{\bar{A}} = 0$$

2.14 (c)

$$\bar{\bar{A}} : \bar{a}\bar{a}^* = 0 \qquad \forall \bar{a}$$

$\bar{a} = \bar{b} + \bar{c}$

$\uparrow \quad \uparrow$

real

$$\bar{\bar{A}} : \bar{b}\bar{c} = -\bar{\bar{A}} : \bar{c}\bar{b}$$

$$\bar{\bar{A}} : (\bar{b}+\bar{c})(\bar{b}+\bar{c}) = 0$$

$$= \underbrace{\bar{\bar{A}} : \bar{b}\bar{b}}_{0} + \underbrace{\bar{\bar{A}} : \bar{c}\bar{c}}_{0} + \bar{\bar{A}} : \bar{b}\bar{c} + \bar{\bar{A}} : \bar{c}\bar{b}$$

$$\bar{\bar{A}} : (\bar{b}+j\bar{c})(\bar{b}-j\bar{c}) = 0$$

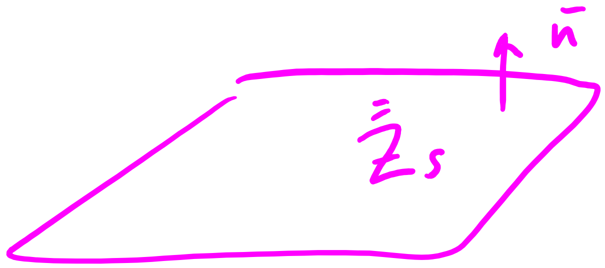
$$= \underbrace{\bar{\bar{A}} : \bar{b}\bar{b}}_{\uparrow 0} + \underbrace{\bar{\bar{A}} : \bar{c}\bar{c}}_{\uparrow 0} + j\left(-\bar{\bar{A}} : \bar{b}\bar{c} + \bar{\bar{A}} : \bar{c}\bar{b}\right)$$

$$j\, 2\bar{\bar{A}} : \bar{c}\bar{b} = 0$$

$$\bar{\bar{A}} : \bar{a}\bar{a} = 0 \qquad \forall \bar{a}$$

$$\bar{\bar{A}} = \bar{b}\bar{c} - \bar{c}\bar{b}$$

$$\bar{\bar{A}} : \bar{a}\bar{a} = (\bar{b}\bar{c} - \bar{c}\bar{b}) : \bar{a}\bar{a} = \underbrace{(\bar{b}\cdot\bar{a})(\bar{c}\cdot\bar{a}) - (\bar{c}\cdot\bar{a})(\bar{b}\cdot\bar{a})}_{=0}$$



$$\bar{E}_t = \bar{\bar{Z}}_s \cdot \bar{n}\times\bar{H}_t$$

$$2.2\ \mathrm{Re}\{\bar{n}\cdot\bar{S}\} = 2\,\mathrm{Re}\{\bar{n}\cdot\bar{E}\times\bar{H}^*\}$$

$$= \bar{n}\cdot\bar{E}\times\bar{H}^* + \underbrace{\bar{n}\cdot\bar{E}^*\times\bar{H}}_{\bar{H}\cdot\bar{n}\times\bar{E}^*} = 0$$

$$\bar{n}\cdot\bar{\bar{Z}}_s\cdot\bar{n}\times\bar{H}\times\bar{H}^*$$

$$= -\bar{\bar{Z}}_s\cdot\bar{n}\times\bar{H}\times\bar{n}\cdot\bar{H}^*$$

$$= -\bar{n}\times\bar{H}\cdot\bar{\bar{Z}}_s^{T}\times\bar{n}\cdot\bar{H}^*$$

$$= \bar{H}\cdot\bar{n}\times\bar{\bar{Z}}_s^{T}\times\bar{n}\cdot\bar{H}^*$$

$$\bar{H}\cdot\bar{n}\times\bar{E}^*$$

$$= \bar{H}\cdot\bar{n}\times\bar{\bar{Z}}_s^{*}\cdot\bar{n}\times\bar{H}^*$$

$$= \bar{H}\cdot\bar{n}\times\bar{\bar{Z}}_s^{*}\times\bar{n}\cdot\bar{H}^*$$

$$\bar{H}\cdot\bar{n}\times\left(\bar{\bar{Z}}_s^{T}+\bar{\bar{Z}}_s^{*}\right)\times\bar{n}\cdot\bar{H}^* = 0 \quad \forall \bar{H}$$

$$\Rightarrow \quad \bar{n}\times\left(\bar{\bar{Z}}_s^{T}+\bar{\bar{Z}}_s^{*}\right)\times\bar{n} = 0$$

LOSSLESS SURFACE: $\bar{\bar{Z}}_s^{T} = -\bar{\bar{Z}}_s^{*}$

$$\bar{\bar{Z}}_s = Z_s\bar{\bar{I}}_t \rightarrow Z_s\bar{\bar{I}}_t = -Z_s^*\bar{\bar{I}}_t$$

$$\Rightarrow Z_s = jX_s$$

$\bar{\bar{I}}_t$, $\bar{\bar{J}}$, $\bar{\bar{K}}$, $\bar{\bar{L}}$

$\Rightarrow$

$$\bar{\bar{Z}}_s = \frac{1}{M}\bar{\bar{J}} \qquad \textbf{PEMC}$$

$\bar{n} \times \bar{\bar{I}}_t$

$\bar{\bar{Z}}_s = \frac{1}{M} \bar{\bar{J}}$

PEMC

LOSSLESS $\rightarrow -\frac{1}{M} \bar{\bar{J}} = -\frac{1}{M^*} \bar{\bar{J}}$

PEMC

$$M\bar{E} = -\bar{H}$$

$$\bar{E}_t = \bar{\bar{Z}}_s \cdot \bar{n} \times \bar{H} = \frac{1}{M} \underbrace{\overbrace{\bar{n} \times (\bar{n} \times \bar{H})}^{-\bar{H}_t}}_{-\bar{n}\bar{n} \times \bar{\bar{I}} \cdot \bar{H}}$$

$$\uparrow \frac{1}{M} \bar{\bar{J}} = \frac{1}{M} \bar{n} \times \bar{\bar{I}}$$