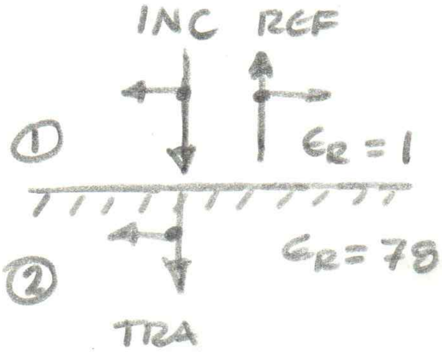
PROBLEM D12.1



BOTH MEDIA ARE LOSS LESS

$$\eta_1 = 377\,\Omega$$

$$\eta_2 = \frac{377}{\sqrt{78}} = 42.7\,\Omega$$

$$\Gamma = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} = \frac{42.7 - 377}{42.7 + 377} = -0.796$$

VOLTAGE REFLECTION COEFFICIENT

$$|\Gamma|^2 = 0.63$$

POWER REFLECTION COEFFICIENT

$$\tau = \frac{2\eta_2}{\eta_2 + \eta_1} = \frac{2 \times 42.7}{42.7 + 377} = 0.20$$

$$1 - |\Gamma|^2 = 0.37$$

POWER TRANSMISSION COEFFICIENT

$$E_t = E_o \tau = 1.0 \times 0.20 = 0.20\ \text{V/m}$$

AMPLITUDE OF THE ELECTRIC FIELD THAT IS TRANSMITTED INTO THE LAKE.

PROBLEM D12.2

$$s = \frac{V_{max}}{V_{min}} = \frac{1+|\Gamma|}{1-|\Gamma|}$$

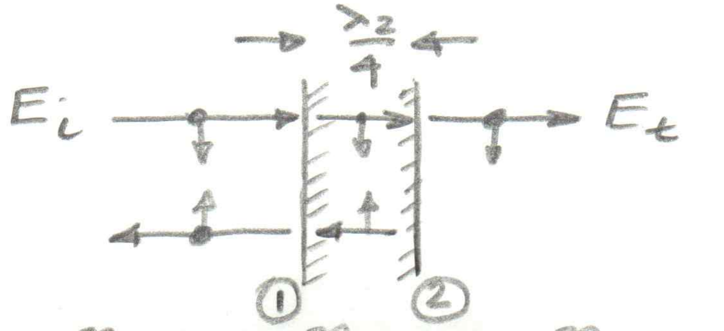
V_{max} OCCURS WHEN E_i AND E_r ARE PERFECTLY IN PHASE.

V_{min} OCCURS WHEN E_i AND E_r ARE PERFECTLY OUT OF PHASE.

IF $\Gamma = \pm 1/2$, $|\Gamma| = 1/2$

$$s = \frac{1+1/2}{1-1/2} = \frac{1.5}{.5} = \boxed{3}$$

PROBLEM D12.3



$$\eta_w = \frac{\eta_2^2}{\eta_3} \qquad \Gamma_1 = \frac{\eta_w - \eta_1}{\eta_w + \eta_1}$$

IF WE CAN FIND THE INPUT OR WAVE IMPEDANCE AT THE FIRST INTERFACE, WE CAN SOLVE FOR Γ_1.

IN THIS CASE, FINDING η_w IS TRIVIAL BECAUSE THE SLAB IS ACTING LIKE A $\lambda/4$ TRANSFORMEROR SECTION.

$$\eta_w \eta_3 = \eta_2^2 \;, \quad \eta_w = \frac{\eta_2^2}{\eta_3} = \frac{260^2}{377}$$

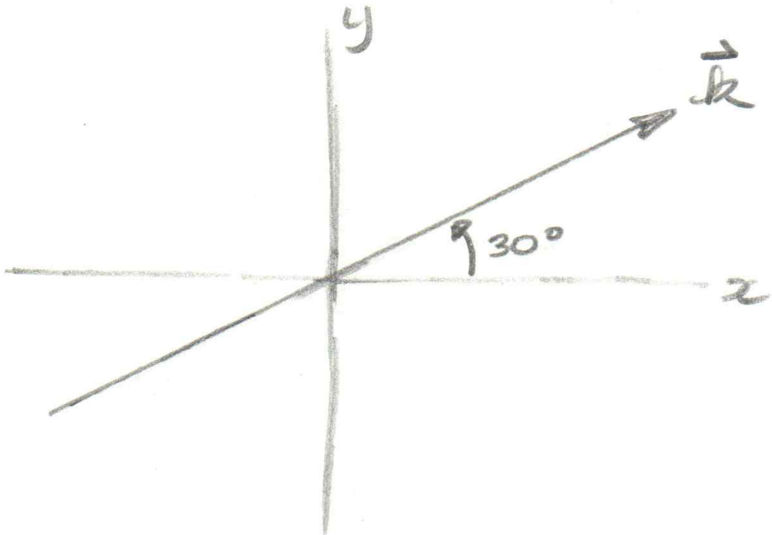
$$= 179.3\,\Omega$$

$$\Gamma_1 = \frac{\eta_w - \eta_1}{\eta_w + \eta_1} = \frac{179.3 - 377}{179.3 + 377}$$

$$= -0.355$$

$$|\Gamma_1| = 0.355 \qquad \measuredangle \Gamma_1 = -180^\circ$$

PROBLEM D12.4



$|k| = \beta$

$k_x = k\cos\theta$

$= \frac{\pi\sqrt{3}}{2}$ rad/m

$k_y = k\sin\theta$

$= \frac{\pi}{2}$ rad/m

LOSSLESS MEDIUM SO $\beta = \omega\sqrt{\mu\epsilon}$

$= \frac{\omega}{c}\sqrt{\epsilon_R}$

$= \frac{2\pi}{\lambda}\sqrt{\epsilon_R}$

$= \pi$ rad/m

$= |k|$

$k_x = \frac{\pi\sqrt{3}}{2}$ rad/m

$= \frac{2\pi}{\lambda_x}$

$\lambda_x = \boxed{2.31\ m}$

$k_y = \frac{\pi}{2}$ rad/s

$= \frac{2\pi}{\lambda_y}$

$\lambda_y = \boxed{4\ m.}$

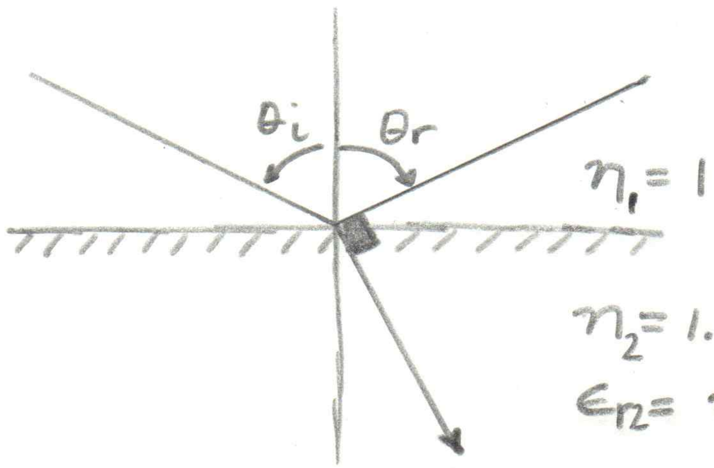
$v_x = \frac{\omega}{k_x} = \frac{2\pi \times 50 \times 10^6}{\frac{\pi\sqrt{3}}{2}}$

$= \boxed{1.155 \times 10^8\ m/s}$

$v_y = \frac{\omega}{k_y} = \frac{2\pi \times 50 \times 10^6}{\pi/2}$

$= \boxed{2.00 \times 10^8\ m/s}$

PROBLEM 12.5



REFRACTIVE INDEX $= \sqrt{\epsilon_r}$

$$\tan\theta_B = \sqrt{\frac{\epsilon_{r2}}{\epsilon_{r1}}} = 1.45$$

$$\theta_B = \tan^{-1}(1.45) = 55.4^\circ = \theta_i = \theta_r$$

$$\theta_t = 90^\circ - 55.4^\circ = 34.6^\circ$$

$$\cos 55.4^\circ = 0.5678$$

$$\cos 34.6^\circ = 0.8231$$

S-polarized light ≡ TE polarization

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

$$= \frac{n_1 \cos\theta_i - n_2 \cos\theta_t}{n_1 \cos\theta_i + n_2 \cos\theta_t}$$

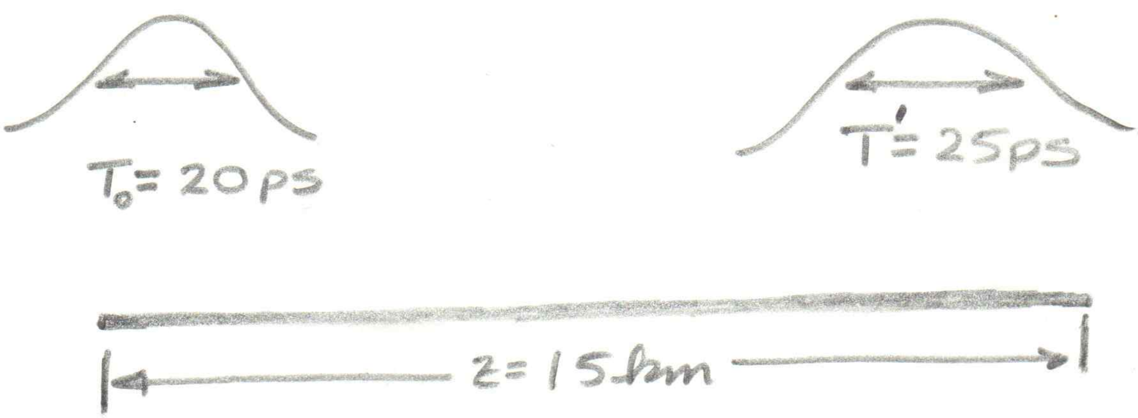
$$= -0.3552$$

(ONE CAN REFORMULATE Γ_{TE} IN TERMS OF n.)

PROBLEM D12.6

This is being included for completeness. It's not part of our syllabus.

$\beta_2 = 20\ ps^2/km$ = DISPERSION PARAMETER



$$\Delta T = \frac{\beta_2 z}{T} = \frac{20 \times 15}{20} = 15\ ps.$$

$$T' = \sqrt{T^2 + \Delta T^2}$$

$$= \sqrt{20^2 + 15^2}$$

$$= 25\ ps.$$

(THE WIDTH OF THE PULSE IS MEASURED BETWEEN THE POINTS THAT ARE $1/e$ OF THE PEAK.)