$$(1 + e^{-2i\theta})e^{i\theta}$$

$$e^{i\theta} + e^{-i\theta} = \underline{2\cos\theta}$$

Real part $2\cos\theta$

Magnitude $2\cos\theta$

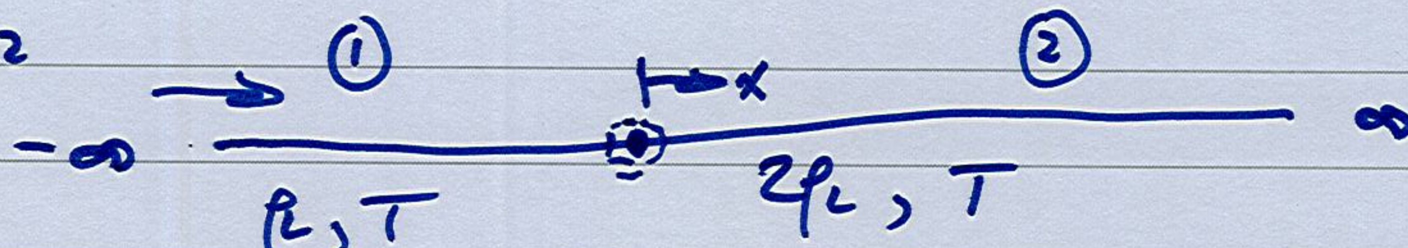
Phase = 0

Homework Hints

2.4.1

$$\underline{\frac{\partial^2 y}{\partial x^2}} - \frac{1}{c^2}\underline{\frac{\partial^2 y}{\partial t^2}} = 0$$

2.8.2



$$y_1(x,t) = \underline{A e^{j(\omega t - kx)}} + \underline{\underline{B e^{j(\omega t + kx)}}}$$

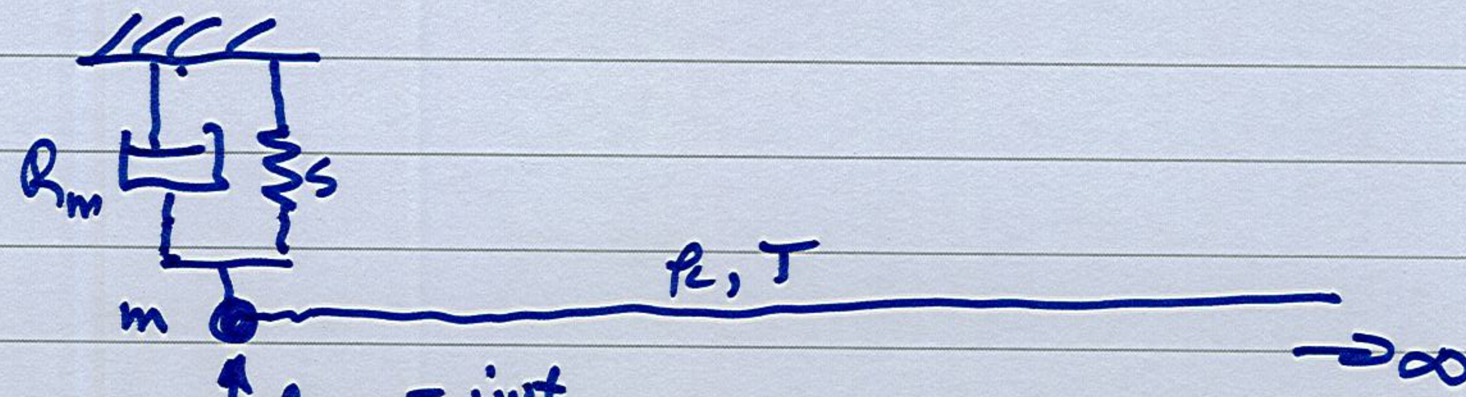
reflected

$$y_2(x,t) = C e^{j(\omega t - kx)}$$

2 b.c.'s – displacement continuity at $x=0$

$\Sigma f_y = 0$

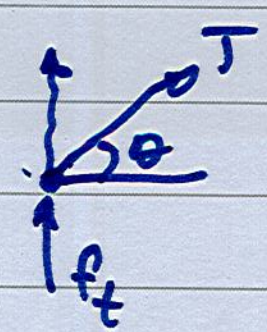
2.9.2



$f_t = F e^{j\omega t}$

$$y(x,t) = A e^{j(\omega t - kx)}$$

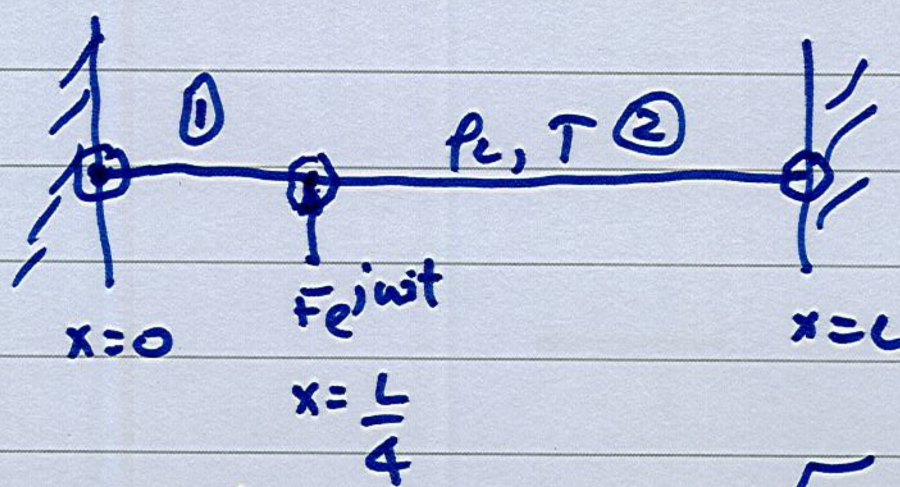
FBD



$$\Sigma f_y = ma$$

$$Z_{m_0} = \frac{F e^{j\omega t}}{\left.\frac{\partial y}{\partial t}\right|_{x=0}}$$

2.9.3



Drive point impedance $\sim \dfrac{Fe^{j\omega t}}{\text{velocity}} \sim \dfrac{\partial y_1}{\partial t}, \dfrac{\partial y_2}{\partial t}$

$y_1 = Ae^{j(\omega t - kx)} + Be^{j(\omega t + kx)}$

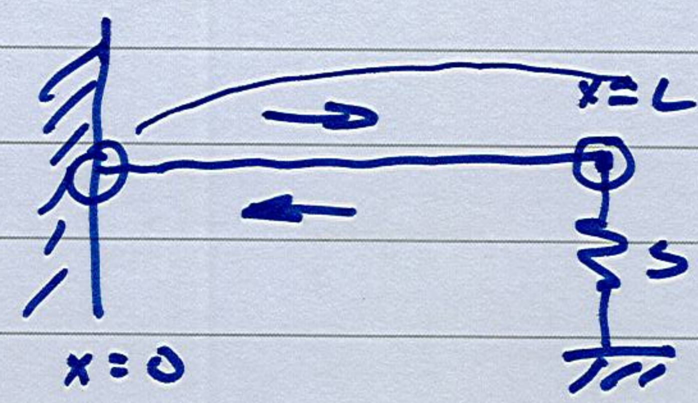
$y_2 = C \qquad D$

4 unknowns

4 b.c.'s

$\underline{(1 + e^{2jkL})}$ $\qquad e^{jkL}\underbrace{(e^{-jkL} + e^{jkL})}_{2\cos kL}$

2.11.1



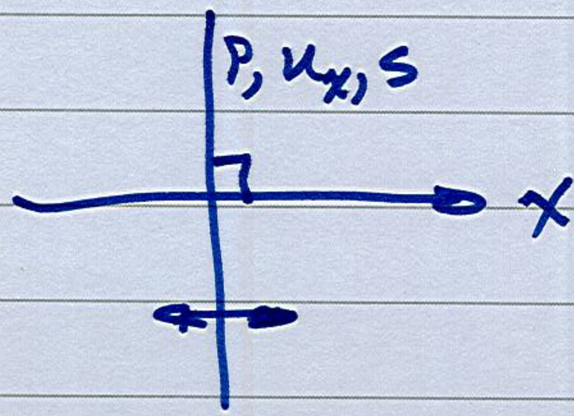
$T = sL$

Apply 2 b.c.'s

→ characteristic Eqn

solve for

$\underline{\underline{(kL)_1}}$ & $\underline{\underline{(kL)_2}}$

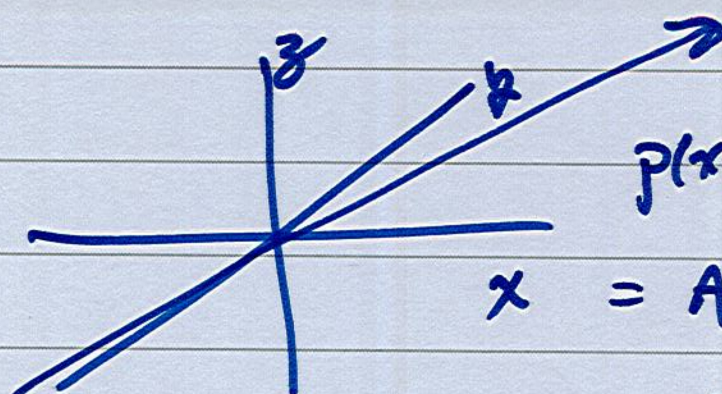


$$\hat{p}(x,t) = \left(A e^{-ikx} + B e^{ikx}\right) e^{j\omega t}$$

plane wave

$$\hat{u}_x(x,t) = \left(\frac{A}{\rho_0 c} e^{-ikx} - \frac{B}{\rho_0 c} e^{+ikx}\right) e^{j\omega t}$$

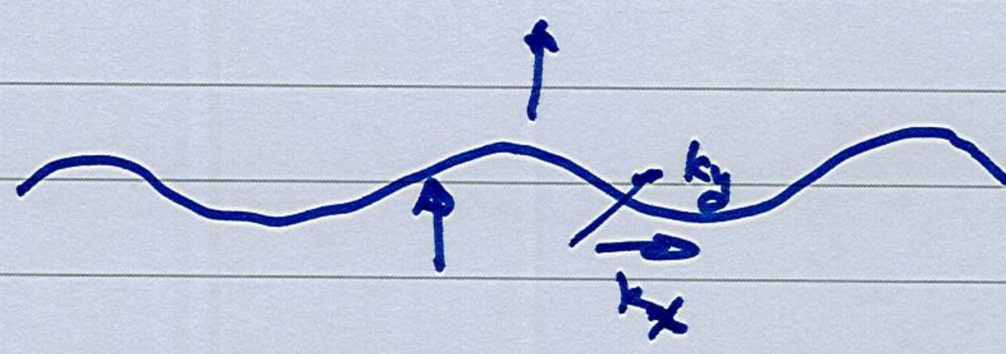
$$\hat{u}_x = -\frac{1}{j\omega\rho_0} \frac{\partial \hat{p}}{\partial x}$$



$$p(x,y,z,t) = A e^{i(\omega t - k_x x - k_y y - k_z z)}$$

$$\underline{k}^2 = \underline{k}_x^2 + \underline{k}_y^2 + \underline{k}_z^2$$

only 2 of the k_x, k_y & k_z can be chosen independently if the solution represents sound

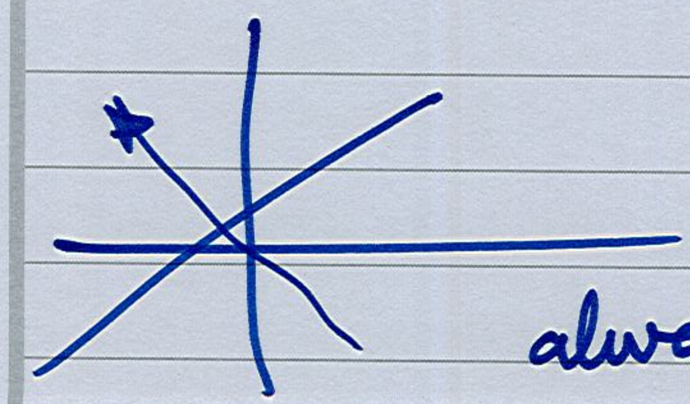


$$k_z = \sqrt{k^2 - k_x^2 - k_y^2}$$

$$\tilde{p}(x,y,z,t) = A e^{j(\omega t \pm k_x x \pm k_y y \pm k_z z)}$$

any combination is possible

8



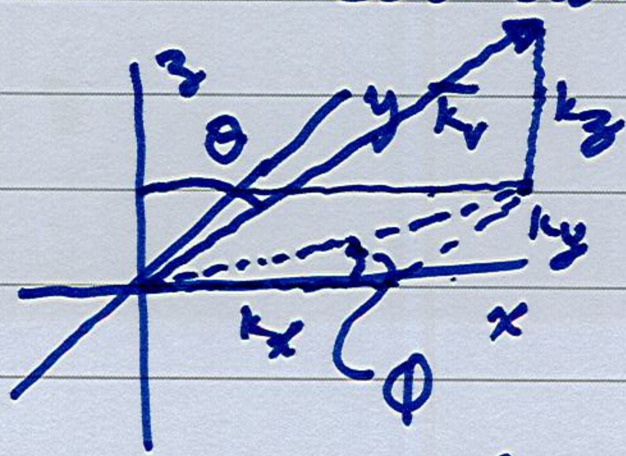
always be true

$$k^2 = k_x^2 + k_y^2 + k_z^2$$

Wave vector

- vector direction of wave prop
- components - rate of change of phase with position wrt the coordinate directions

$$A e^{j(\omega t - \bar{k}_v \cdot \bar{x})}$$



$$\bar{k}_v = k_x \bar{i} + k_y \bar{j} + k_z \bar{k}$$

$$|\bar{k}_v| = k = \frac{\omega}{c}$$

θ = polar angle

$$k_x^2 + k_y^2 + k_z^2 = k$$

φ = azimuth

$$k_z = k \cos\theta$$

$$k_x = k \sin\theta \cos\phi$$

$$k_y = k \sin\theta \sin\phi$$

$$k_z^2 = \underset{\substack{\text{fixed} \\ \text{by} \\ \text{the freq} \\ \text{of the problem}}}{k^2} - \underbrace{k_x^2 - k_y^2}_{\substack{\text{fixed by} \\ \text{b.c.'s}}}$$

(say a vibrating plate)

$$k_z = \pm\sqrt{k^2 - k_x^2 - k_y^2}$$

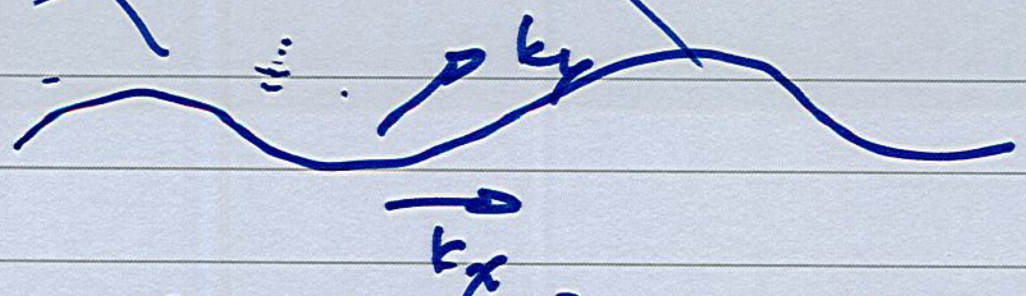
(i) if $k_x^2 + k_y^2 > k^2$ $\quad \sqrt{-ve}$

$$k_z = \pm j \underbrace{\sqrt{k_x^2 + k_y^2 - k^2}}_{\alpha} = \pm j\alpha$$

$k_z = \pm j\alpha \qquad e^{\pm jk_z z}_{\underbrace{}_{\alpha}} \rightarrow \underbrace{e^{\pm \alpha z}}$

pure exponential growth or decay.

<u>evanescent</u> or non-propagating



(ii) $k_x^2 + k_y^2 < k^2 \rightarrow k_z = \text{real}$

$e^{\pm jk_z z}$] oscillations in the z direction $\rightarrow$ prop

Consider two-dimensional case

- no variation in the z-direction

$k_z = 0$