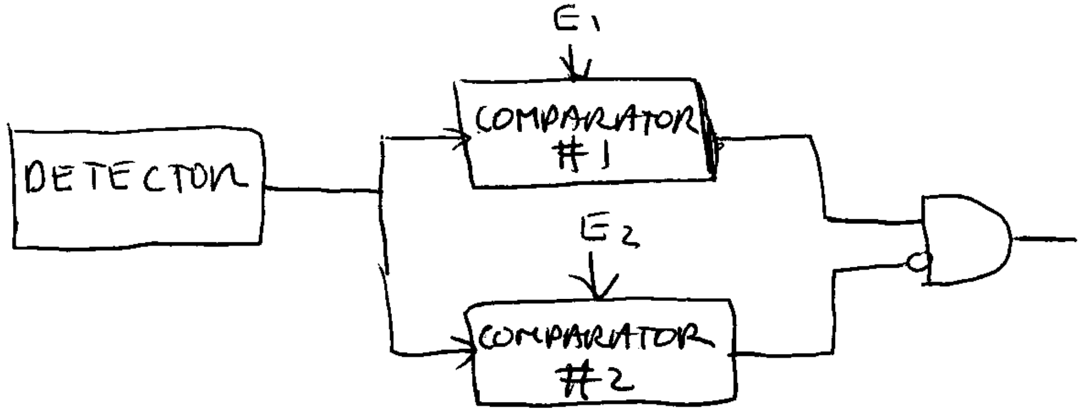
EE 5345
SOLUTIONS

12.11, 12.18, 12.20, 12.22, 12.23

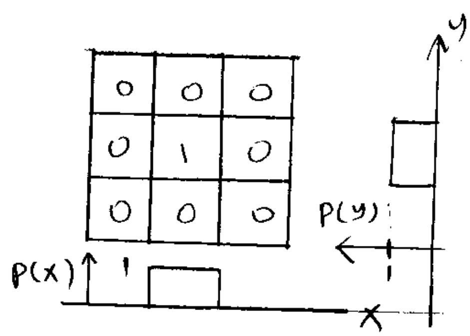
12.20) PULSE HEIGHT ANALYZER:



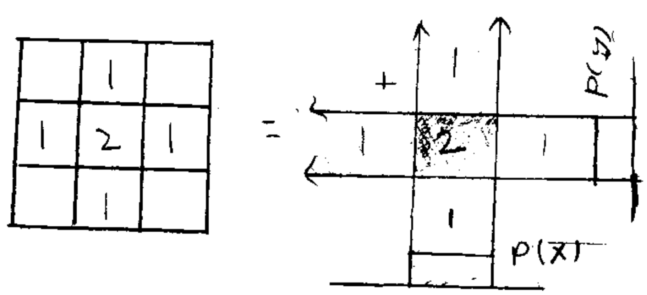
WANT TO DETECT ENERGY BETWEEN E_1 AND E_2.

12.11) USE 12.15, PLUG IN.

12.18



back-projected image:
= sum of back projections of p(x) + p(y)



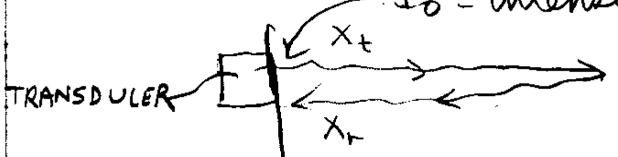
12.22) $h(x) = K e^{-2|x|}$

$$S(w) = K\int_{-\infty}^{\infty} e^{-2|x|} e^{-jwx}\,dx = K\int_{-\infty}^{0} e^{+2x} e^{-jwx}\,dx + K\int_{0}^{\infty} e^{-2x} e^{-jwx}\,dx$$
$$= K\int_{-\infty}^{0} e^{x(2-jw)}\,dx + K\int_{0}^{\infty} e^{-x(2+jw)}\,dx$$
$$= K\int_{0}^{\infty} e^{-x(2-jw)}\,dx + \int_{0}^{\infty} e^{-x(2+jw)}\,dx$$
$$= K\left(\frac{1}{2-jw} + \frac{1}{2+jw}\right) = \frac{4K}{4+w^2}$$

$$(w) = \frac{4K}{4+w^2}, \quad w = 2\pi f$$

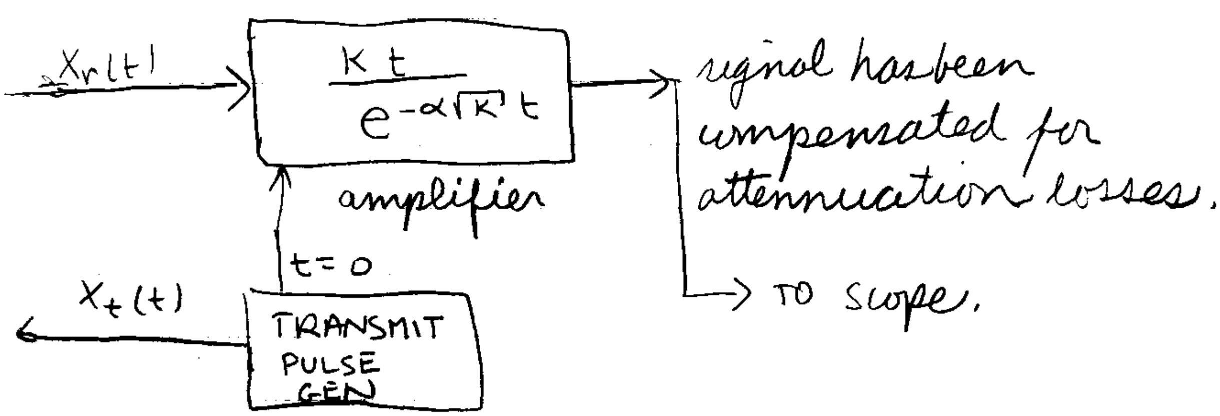
12.23) Block diagram of A-mode ultrasonic signal amp that corrects for ultrasonic attenuation w/ distance.

I_0 = intensity at $r = 0$



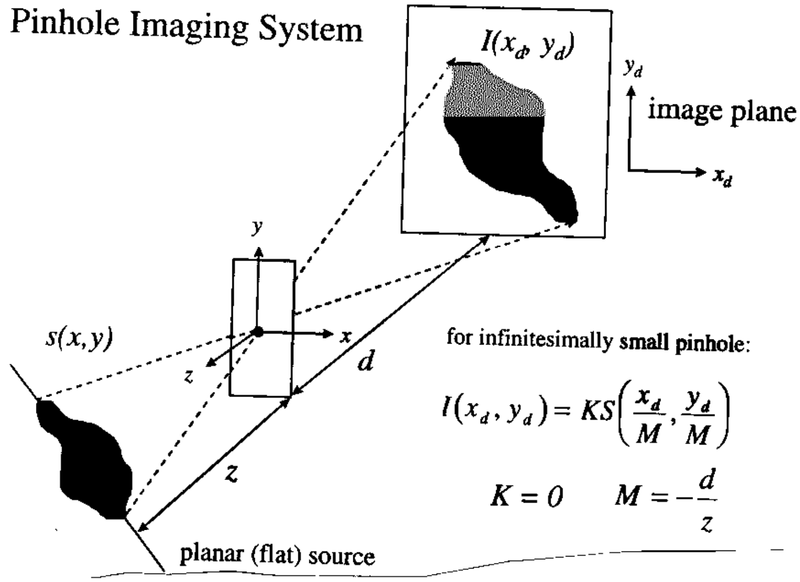
as the ultrasound propagates through tissue it undergoes attenuation. After having travelled a distance r:

$$I = \frac{I_0 e^{-\alpha r}}{r} \quad \text{but } r \propto t \text{, say } r = Kt$$



2.

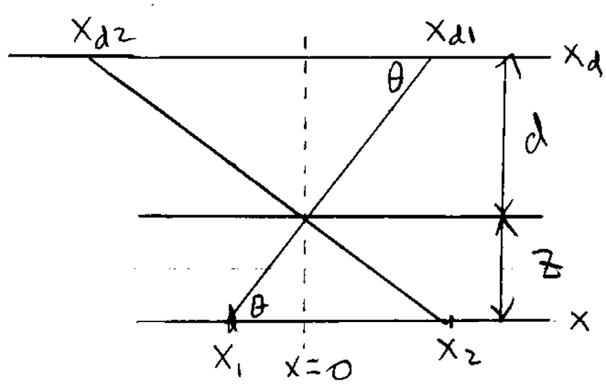
Pinhole Imaging System



for infinitesimally small pinhole:

$$I(x_d, y_d) = KS\left(\frac{x_d}{M}, \frac{y_d}{M}\right)$$

$$K = 0 \qquad M = -\frac{d}{z}$$



assume same scale for x and x_d (say, inches)

$$\tan\theta = \frac{z}{x_1} = -\frac{d}{x_{d1}}$$

$$\Rightarrow x_{d_1} = -\frac{d}{z} x_1 \quad \text{in general } x_d = -\frac{d}{z} x$$

$$\equiv Mx$$

Same holds for y-coordinates. In terms of (x, y):

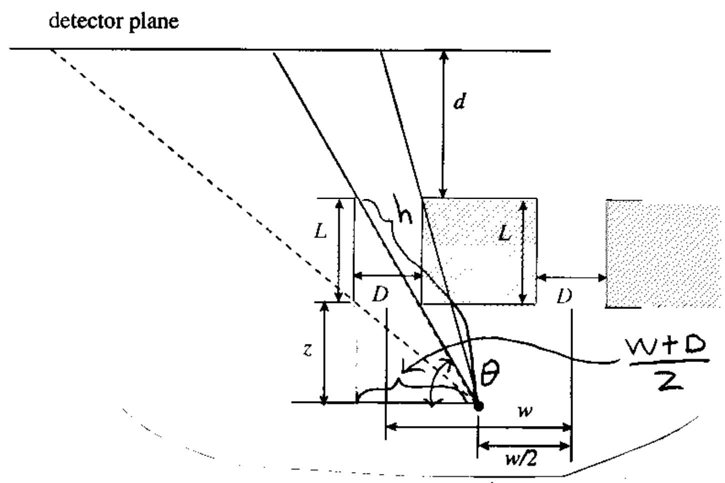
$$I(x,y) = S\left(\frac{x}{M}, \frac{y}{M}\right)$$

or $I(x_d, y_d) = S\left(\frac{x_d}{M}, \frac{y_d}{M}\right)$ since x, x_d, y, y_d use same scale.

3.

Minimum Hole Separation: $w > D\left(1+\frac{2z}{L}\right)$

This is the minimum hole separation, photons will just pass through 2 holes here.



Big triangle:

$$\sin\theta = (Z+L)/h$$

$$\cos\theta = \frac{W+D}{2h} \quad *$$

$$\therefore \tan\theta = \frac{\sin\theta}{\cos\theta} = \frac{2(Z+L)}{W+D} \quad (1)$$

Little triangle:

$$\tan\theta = \frac{L}{D} \quad (2)$$

(1) = (2): $\frac{2(Z+L)}{W+D} = \frac{L}{D}$, solve for w:

$$W > \frac{2ZD}{L} + D$$

* i.e. $\frac{W - D/2 - D/2}{2} + D = \frac{W}{2} + \frac{D}{2}$ = base of triangle