

Q1

$$\delta = 79\% \text{ IACs}$$

$$\begin{array}{c} \downarrow \\ \delta = 0.25 \text{ mm} \\ \uparrow \end{array} \quad 0.75 \text{ mm}$$

$$(i) \quad \delta_{\text{min}} = \frac{661}{\sqrt{f \mu_r \sigma}}$$

$$f = \left(\frac{661}{\delta_{\text{min}}} \right)^2 \cdot \frac{1}{\mu_r \sigma} ; \mu_r = 1$$

$$= \left(\frac{661}{0.25} \right)^2 \cdot \frac{1}{79} = \underline{88.5 \text{ kHz}}$$

$$(ii) \quad \theta = \frac{x}{\delta} \times 57.3 = \frac{0.75}{0.25} \times 57.3 = \underline{171.9^\circ}$$

Increasing test freq. by 2 ;

$$f = 2 \times 88.5 \text{ kHz} = \underline{177 \text{ kHz}}$$

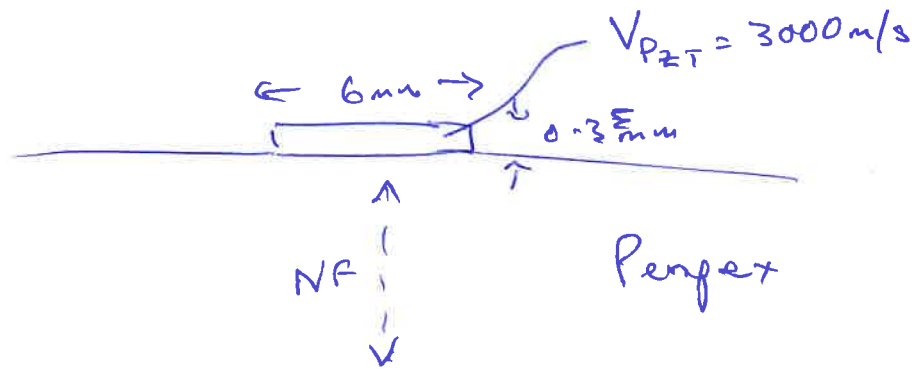
This would signif. reduce the depth of penetration,

$$\delta = \frac{661}{\sqrt{177 \times 10^3 \times 79}} = \underline{0.177 \text{ mm.}}$$

$$\theta = \frac{0.75}{0.177} \times 57.3 = \underline{242.8^\circ} \text{ i.e. larger phase diff. between near \& far.}$$

Q2

a



$$NF = \frac{D^2}{4\lambda} ; \text{ i) Determine } \lambda \text{ in } \text{Pezpex}$$

$$\lambda_p = \frac{V_p}{f}$$

Note: f needs to be determined

$$f_r \times t_h = \frac{V_{pzt}}{2} ; \quad f_r = \frac{V_{pzt}}{2 \times t_h}$$

$$= \frac{3000 \text{ m/s}}{2 \times 0.3 \times 10^{-3}}$$

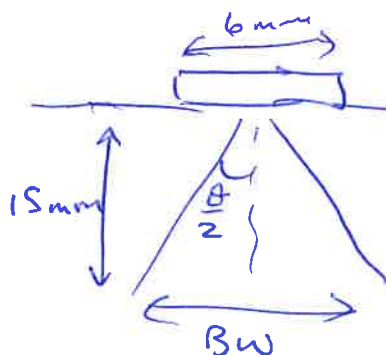
$$= \underline{1.8 \text{ MHz}}$$

$$\therefore \lambda_p = \frac{V_p}{1.8 \times 10^6} = \frac{2680}{1.8 \times 10^6} = \frac{2.68 \times 10^{-3}}{1.8}$$

$$= \underline{1.49 \text{ mm}}$$

$$\therefore NF = \frac{6^2}{4 \times 1.49} = \underline{6.04 \text{ mm}}$$

b



$$\text{Mild steel } \sin \frac{\theta}{2} \approx \frac{1.22 \lambda}{D}$$

$$\lambda_{ms} = \frac{5960}{1.8 \times 10^6} = \underline{3.31 \text{ mm}}$$

③

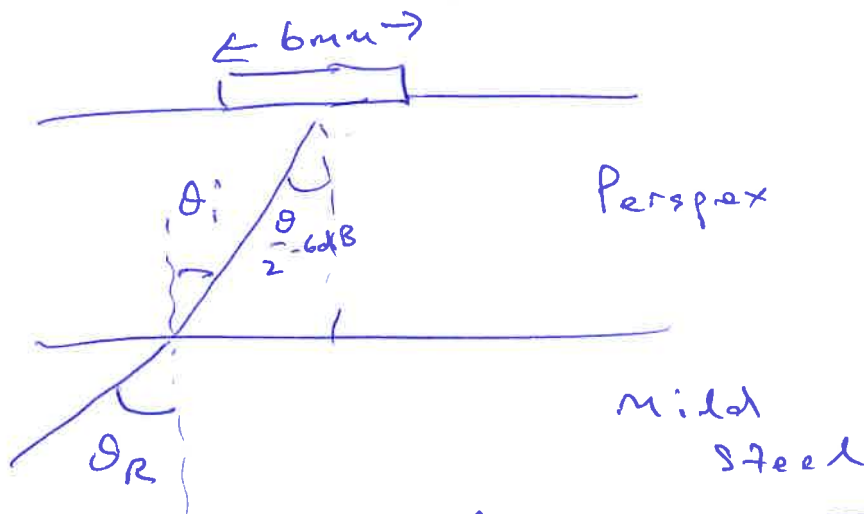
$$\frac{\theta}{2}_{abs} = \sin^{-1} \left[\frac{1.22 \times 3.31}{6} \right]$$

$$= \underline{42.3^\circ}$$

$$\tan 42.3 = \frac{0.5 BW}{15}$$

$$\underline{BW} = 30 \tan 42.3 = \underline{27.3 \text{ mm}}$$

(c)



Note: $\theta_i = \frac{\theta}{2} - 6dB = \frac{0.56\lambda}{2}$

$$\sin \theta_i = \frac{0.56\lambda}{D}$$

From (a) $\lambda = 1.49$

$$\theta_i = \sin^{-1} \left(\frac{0.56 \times 1.49}{6} \right) = 7.994^\circ$$

$$\frac{\sin \theta_i}{V_p} = \frac{\sin \theta_R}{V_s}, \quad \theta_R = \sin^{-1} \left[\frac{V_s}{V_p} \sin \theta_i \right]$$

(4)

$$\theta_R = \sin^{-1} \left[\frac{5960}{2680} \sin 7.994 \right]$$

$$= \underline{18.02^\circ}$$

$$\therefore \frac{\Delta \theta}{2} \text{ -6dB at interface} = 18.02 - 7.994$$

$$= \underline{\underline{10.026^\circ}} \quad *$$

(d) This is not in the course content.

Q3.

(i)



$$I_0 = 0.6 \text{ R/hr}$$

$$\text{HVL}_{\text{lead}} = \cancel{0.178} 0.178 \text{ cm}$$

determine μ_{lead}

$$I_x = I_0 e^{-\mu x}$$

$$\ln \frac{I_x}{I_0} = -\mu x$$

$$\frac{\ln 0.5}{x} = \mu, \quad \mu = -\frac{\ln 0.5}{0.178}$$

$$= 3.894 \text{ cm}^{-1}$$

$$I_{xc} = I_0 e^{-3.894 \times 10}$$

$$= 0.6 e^{-3.894 \times 10}$$

$$= \underline{\underline{7.36 \times 10^{-8} \text{ R/hr.}}}$$

(Q3) (cont)

$$(ii) \quad t = 40 \text{ min} \quad DR = 1.5 \text{ mR/hr}$$

$$DR = \frac{D}{t} ; D = DR \times t$$

$$= 1.5 \times 10^{-3} \times \frac{40}{60}$$

$$= \underline{1 \text{ mR} \#}$$

$$(iii) \quad \text{Max } D = 1.25 \text{ mR.}$$

$$t = \frac{D}{DR} = \frac{1.25}{1.5} = 0.83 \text{ hrs}$$

$$= \underline{50 \text{ min.}}$$

(iv)

Diagram showing two paths from a source 'x':

- Path 1: Distance $D_1 = 4 \text{ m}$, Intensity $I_1 = 30 \text{ R/hr}$
- Path 2: Distance D_2 , Intensity $I_2 = 1.25 \text{ mR/hr}$

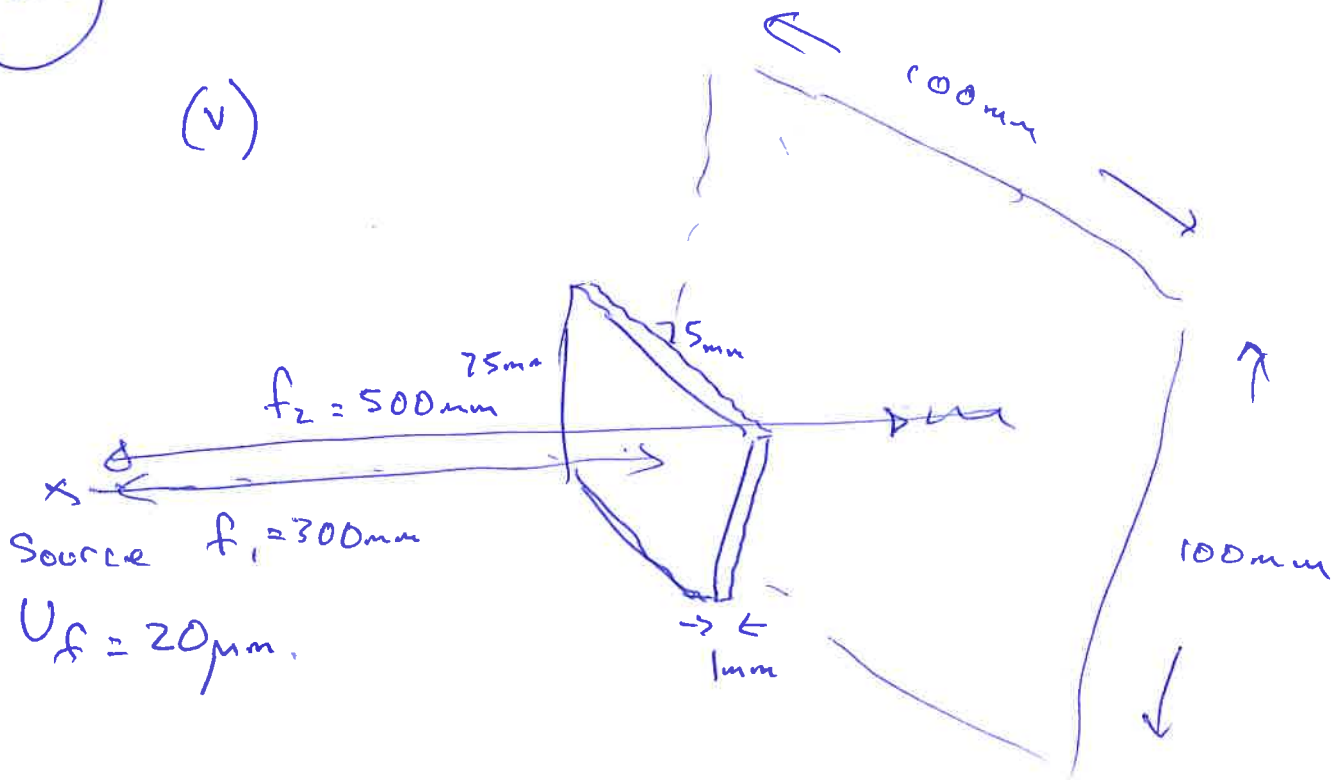
$$\frac{D_1^2}{D_2^2} = \frac{I_2}{I_1} ; D_2 = \left(\frac{D_1^2 \cdot I_1}{I_2} \right)^{0.5}$$

$$= \left(\frac{4^2 \times 30}{1.25 \times 10^{-3}} \right)^{0.5}$$

$$= \underline{619 \text{ m.}}$$

Q3 cont.

(v)

Geometric
Unsharpness

$$U_g = U_f \left(\frac{f_2 - f_1}{f_1} \right)$$

$$= 20 \times 10^{-6} \left(\frac{500 - 300}{300} \right) \times 10^{-3}$$

$$U_g = \underline{13.3 \mu\text{m}} \quad *$$

$$\text{Mag. factor} = \frac{0.5}{0.3} = \underline{1.67} \quad *$$

Think about any implications?