Part I: (5)

1. $R_A =$ 2.4 Ω 1/2

(1)

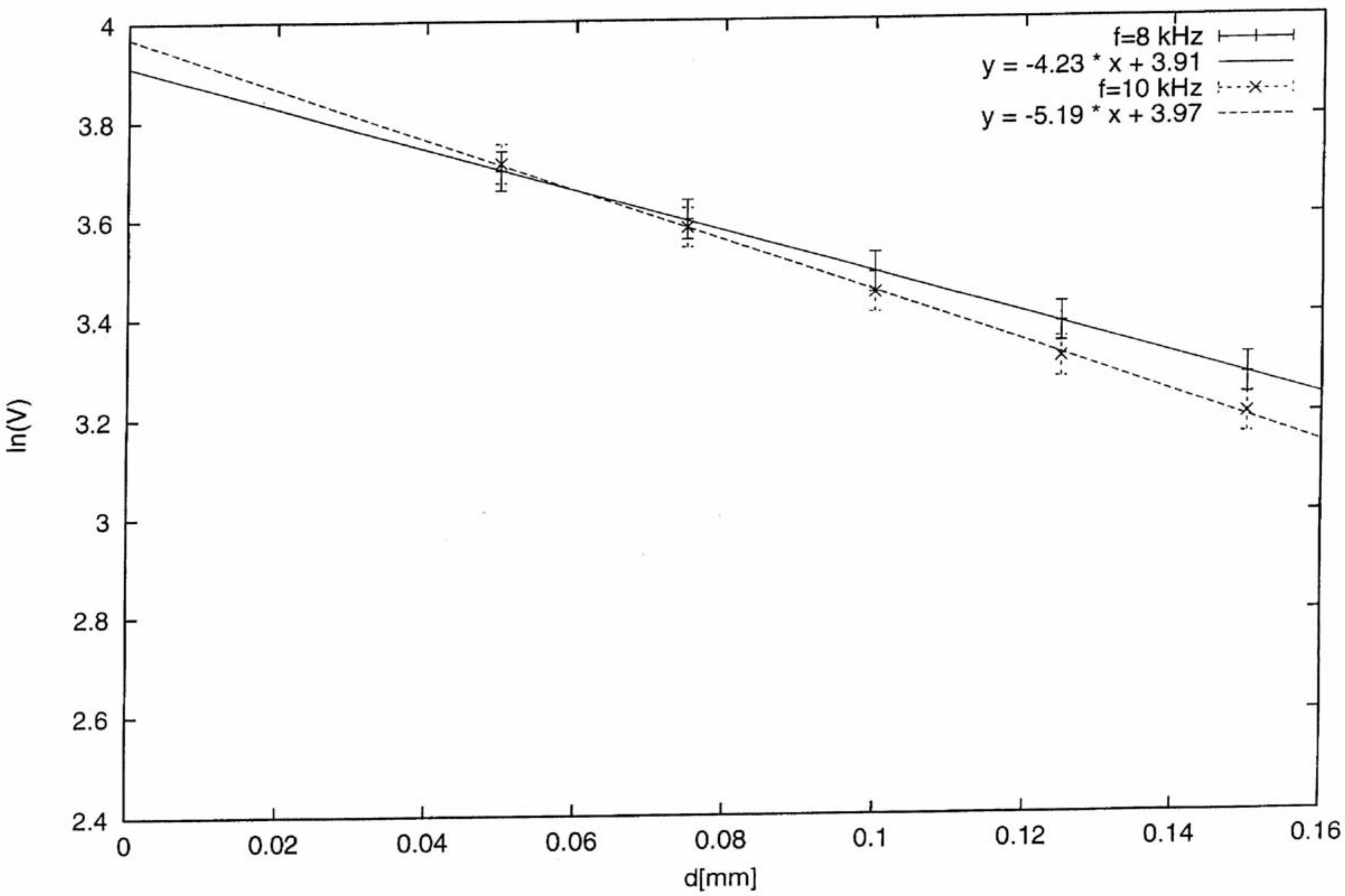
$R_B =$ 1.7 Ω 1/2

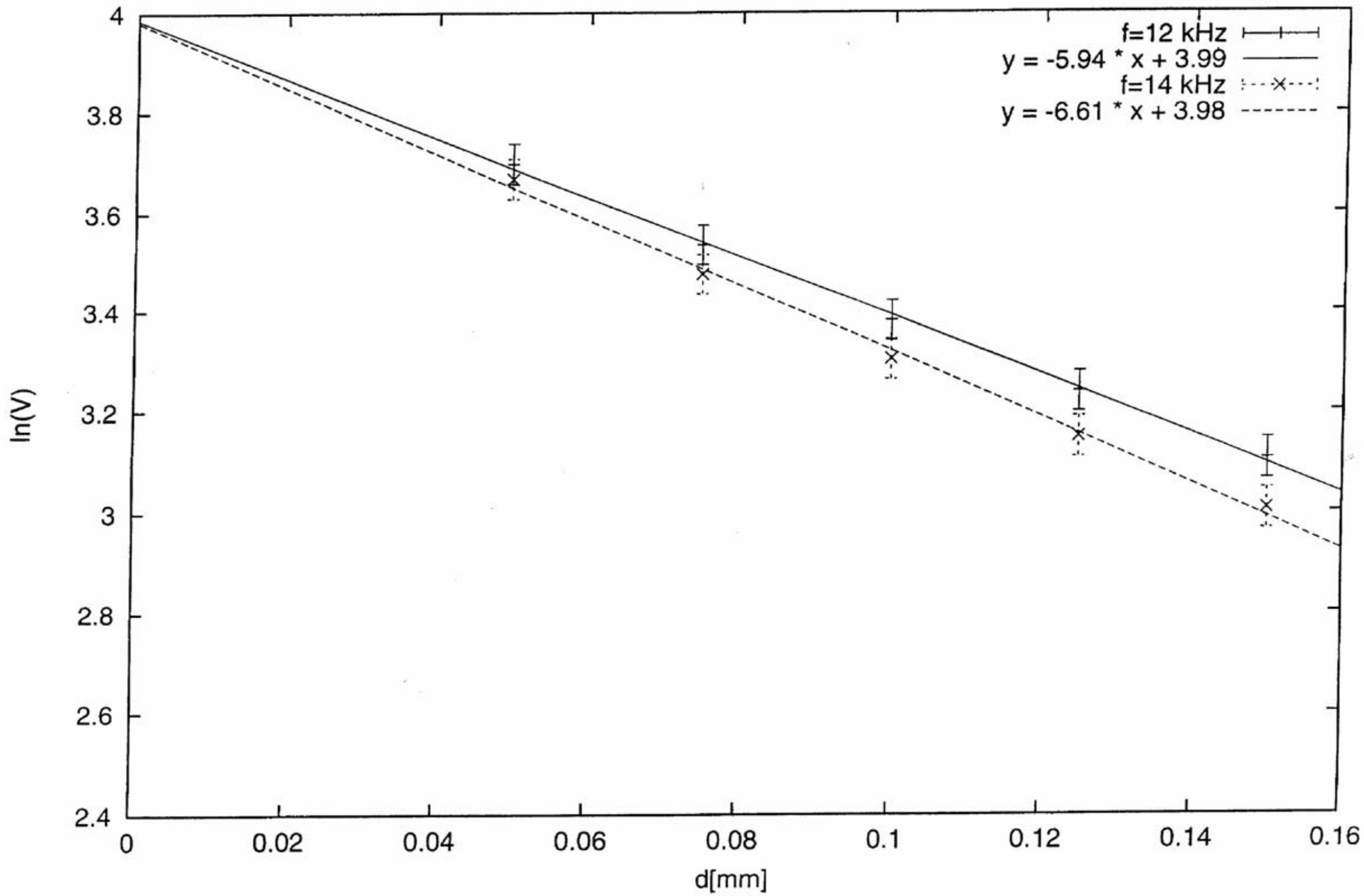
2.

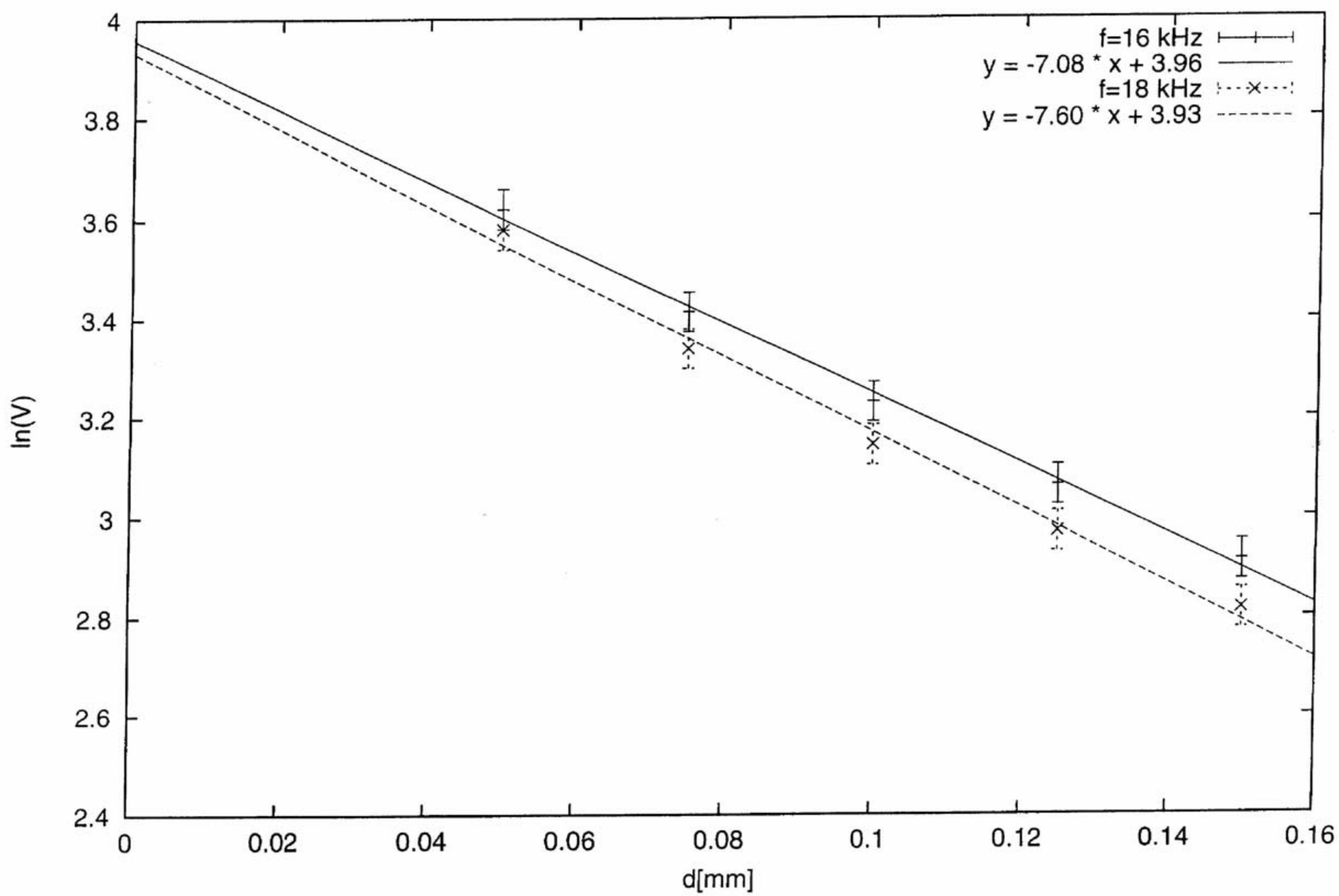
f (kHz)					
α mm⁻¹					

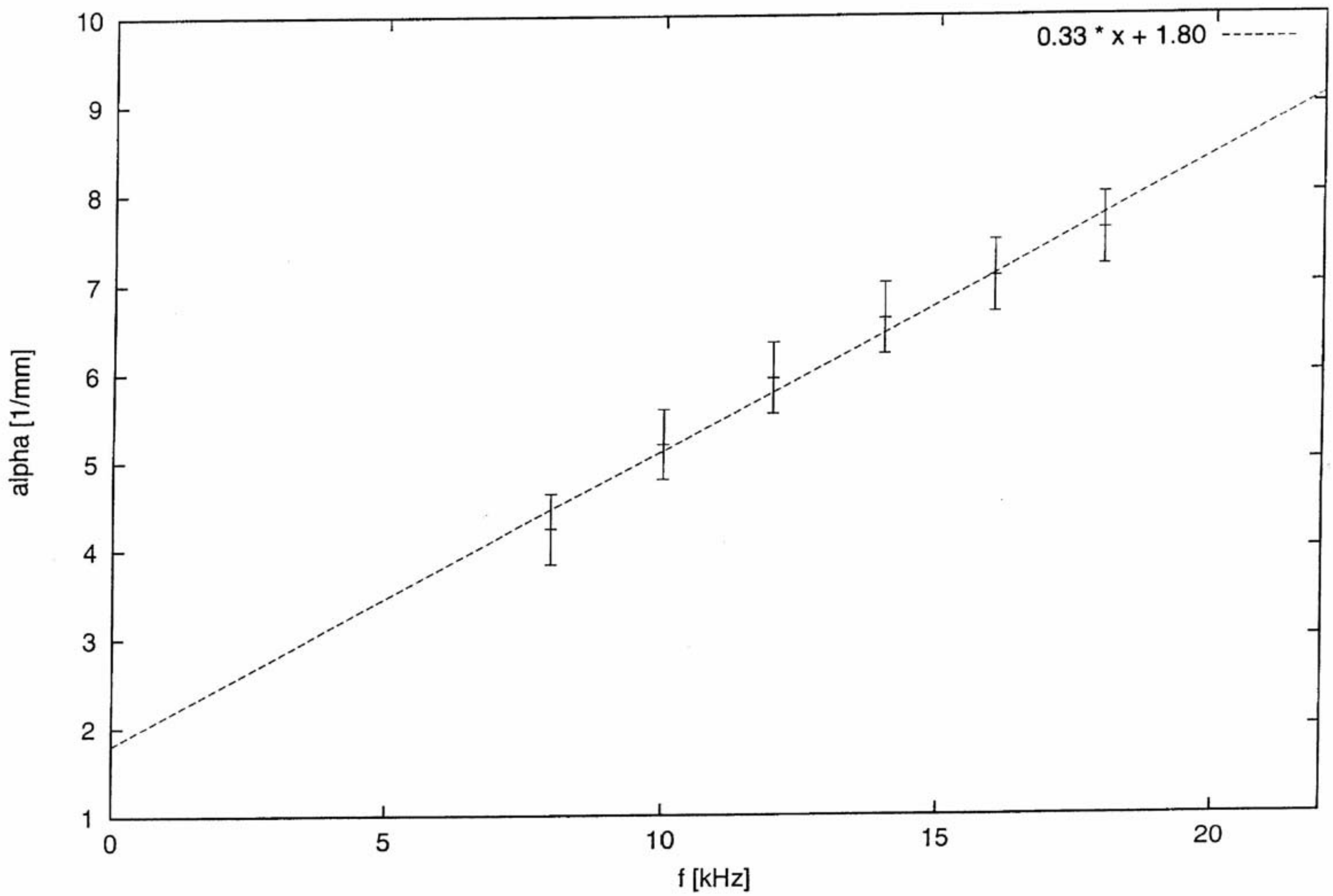
(5)

3. $\alpha(f) = (a \pm \Delta a)\,\mathrm{mm}^{-1} + (b \pm \Delta b)\,\frac{\mathrm{mm}^{-1}}{\mathrm{kHz}}\, f$ (1)


f=8 kHz
y = -4.23 * x + 3.91
f=10 kHz
y = -5.19 * x + 3.97
ln(V)
d[mm]
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16


f=12 kHz
y = -5.94 * x + 3.99
f=14 kHz
y = -6.61 * x + 3.98
ln(V)
d[mm]
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16


f=16 kHz
y = -7.08 * x + 3.96
f=18 kHz
y = -7.60 * x + 3.93
ln(V)
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
d[mm]


0.33 * x + 1.80
alpha [1/mm]
f [kHz]
10
9
8
7
6
5
4
3
2
1
0
5
10
15
20

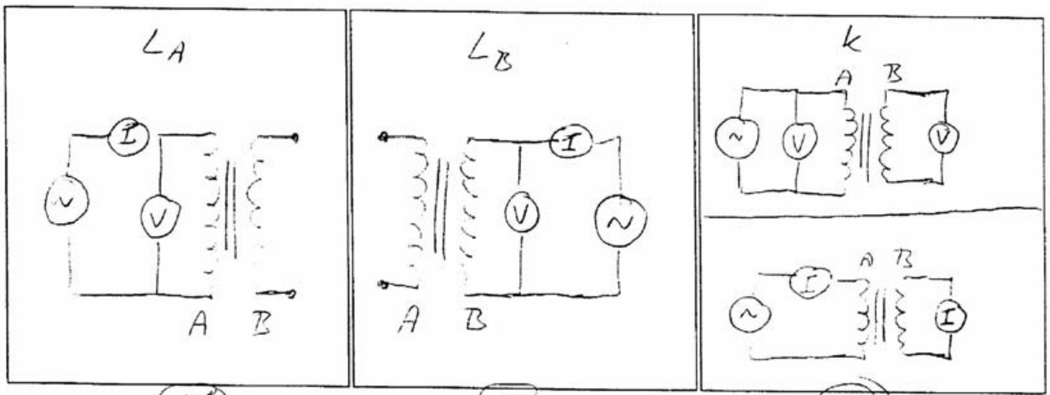
Part II: (12)

1.a. $L_A = \frac{\mathcal{E}_A}{\omega I_A}$, $I_B = 0$ (1/2)

$L_B = \frac{\mathcal{E}_B}{\omega I_B}$, $I_A = 0$ (1/3)

$k = \frac{N_A}{N_B}\frac{\mathcal{E}_B}{\mathcal{E}_A}$, $I_B = 0$ | $k = \frac{N_B}{N_A}\frac{I_B}{I_A}$ $V_B = 0$ (1/3)

1.b.



(1/2) (1/2) (1/2)

1.c. $L_A =$ 34 ± 3 mH (1/3)

$L_B =$ 15 ± 1 mH (1/3)

$k =$ [illegible] (1/2)

2.a. $I_p = \dfrac{\varepsilon_A}{\omega L_A (1 - k^2)}$, $V_B = 0$ 1

2.b. $I_p =$ 66 ± 3 mA 1

3.1. $L_{A+B} =$ 95 ± 6 mH ½

3.2.a. $V_A =$ 16.0 ± 0.6 V ½

$V_B =$ 8.4 ± 0.3 V ½

3.2.b. $\frac{V_A}{V_B} =$ 1.91 ± 0.12 ½

3.2.c. $\frac{V_A}{V_B} = \dfrac{N_A^2 - k N_A N_B}{N_B^2 - k N_A N_B}$ ½

4. $\frac{L}{N^2} = C$ $\frac{1}{2}$

$\frac{L_A}{N_A^2} = 1.5 \cdot 10^{-6} H$ $\frac{L_B}{N_B^2} = 1.5 \cdot 10^{-6} H$ $\frac{L_{A+B}}{(N_A + N_B)^2} = 1.5 \cdot 10^{-6} H$ $\frac{1}{2}$

5. $R_A = 2.4 \Omega \ll (\omega L_A)_{min} (1 - k^2) \simeq 100 \Omega$ (1)

6.a. $\mu_r = \frac{l_f}{d} \left(\frac{V_1}{I_1} \frac{I_2}{V_2} - 1 \right) = \frac{l_f}{d} \left(\frac{L_1}{L_2} - 1 \right)$ (1)

6.b. $\mu_r = \underline{2300 \pm 400}$ (1)

Part II

1. A primary B secondary $f = 10\,kHz$

$$L_A = \frac{\mathcal{E}_A}{\omega I_A}, \quad I_B = 0$$

B primary A secondary

$$L_B = \frac{\mathcal{E}_B}{\omega I_B}, \quad I_A = 0$$

A primary B secondary

Secondary open $I_B = 0$

$$\left.\begin{aligned} \mathcal{E}_A &= c\omega N_A^2 I_A \\ \mathcal{E}_B &= c\omega k N_A N_B I_A \end{aligned}\right\} \quad k = \frac{N_A}{N_B}\frac{\mathcal{E}_B}{\mathcal{E}_A}$$

or

secondary closed $\mathcal{E}_B = 0$

$$\mathcal{E}_B = c\omega N_B (N_B I_B - k N_A I_A) = 0$$

$$\Rightarrow k = \frac{N_B}{N_A}\frac{I_B}{I_A}$$

Part II

2. A primary B secondary $f = 10 kHz$

Open secondary $\mathcal{E}_A = c\omega N_A^2 I_A = \omega L_A I_A$

$$\Rightarrow L_A = c N_A^2$$

Closed secondary

$$\mathcal{E}_A = c\omega N_A (N_A I_A - k N_B I_B)$$

$$\mathcal{E}_B = c\omega N_B (N_B I_B - k N_A I_A) = 0$$

$$\Rightarrow I_B = k \frac{N_A}{N_B} I_A$$

$$\Rightarrow \mathcal{E}_A = \omega c N_A^2 (1-k^2) I_A = \omega L_A (1-k^2) I_A$$

$$I_p = I_A = \frac{\mathcal{E}_A}{\omega L_A (1-k^2)}$$

Part II

3.2.c Flux subtraction

$$I = I_A = I_B$$

$$V_A = \mathcal{E}_A = \omega c N_A I (N_A - k N_B)$$

$$V_B = \mathcal{E}_B = \omega c N_B I (N_B - k N_A)$$

$$\frac{V_A}{V_B} = \frac{N_A^2 - k N_A N_B}{N_B^2 - k N_A N_B}$$

Part II

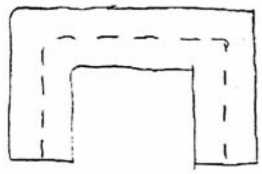
4. $L = cN^2$ $\qquad \frac{L}{N^2} = c$ constant

5. $R_A = 2.4\,\Omega \ll (\omega L_A)_{min}(1-k^2) \simeq 100\,\Omega$

6. Closed magnetic circuit

$$N I_1 = \oint \frac{1}{\mu_f} \bar{B}\cdot d\bar{l} = \frac{2l_f}{\mu_f} B_1$$

$$V_1 = N\dot{\Phi} = \omega N B_1 A$$



l_f length of central dotted line

Papergap circuit

$$N I_2 = \oint \frac{1}{\mu} \bar{B}\cdot d\bar{l} = \left(\frac{2l_f}{\mu_f} + \frac{2d}{\mu_0}\right) B_2$$

$$V_2 = N\dot{\Phi}_2 = \omega N B_2 A$$

$$\frac{I_2 B_1}{B_2 I_1} = 1 + \frac{d}{l_f}\frac{\mu_f}{\mu_0}$$

$$\mu_r = \frac{\mu_f}{\mu_0} = \left(\frac{I_2 B_1}{B_2 I_1} - 1\right)\frac{l_f}{d} = \frac{l_f}{d}\left(\frac{I_2}{V_2}\frac{V_1}{I_1} - 1\right)$$

$$= \frac{l_f}{d}\left(\frac{L_1}{L_2} - 1\right)$$