University of Jordan
School of Engineering
Electrical Engineering Department

10/15

EE 204
Electrical Engineering Lab

EXPERIMENT 6 REPORT & PRE-LAB
INDUCTIVE REACTANCE

Section # _____ **Group #** _____

	Student Name	ID
1.	Lamees Mahmoud Salahat	0154007.
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EXPERIMENT 6
INDUCTIVE REACTANCE

Note: Use MATLAB to quickly perform theoretical calculations by defining a vector of frequencies then using array arithmetic.

PROCEDURE A – AC-EXCITED SERIES RL CIRCUIT

6. Which of the above two methods did you decide to use to measure V_R?

method (A)

7. Can we just subtract the magnitudes of $|V_S| - |V_L|$ to obtain the magnitude $|V_R|$? Why or why not?

No, we can't because they are vectors so we should take the angle in consider.

9. What is the relationship between the periods T of the two signals V_S and V_R?

They equal in magnitude

Table 1

AC Source Frequency (Hz)	V_S (peak) (V)		V_S period T (ms)		V_L (peak) (V)		$\measuredangle V_L$ with V_s (Lead = positive)	
	Theory	Meas.	Theory	Meas.	Theory	Meas.	Theory	Meas.
700	3	3.06	1.43	1.43	0.026	0.025	89.5°	90°
1300	3	3.075	0.769	0.77	0.048	0.05	89.1°	90°
2600	3	3.075	0.385	0.383	0.095	0.1	88.1°	90°
5200	3	3.075	0.192	0.19	0.19	0.21	86.4°	85°
9100	3	3.115	0.101	0.11	0.331	0.35	83.7°	80°
14400	3	3.115	0.069	0.069	0.519	0.54	80°	80°
22200	3	3.2	0.045	0.045	0.784	0.81	74.9°	70°
39200	3	3.2	0.025	0.026	1.29	1.31	64.4°	60°

Table 2

AC Source Frequency (Hz)	V_R (peak) (V)		$\measuredangle V_R$ with V_s (Lag = negative)		V_R period T (ms)		I and $\measuredangle I$ (mA) $= V_R/R$	
	Theory	Meas.	Theory	Meas.	Theory	Meas.	Theory	Meas.
700	3	3.08	−0.5°	0	1.43	1.43	3.66	3.75
1300	3	3.06	−0.9°	0	0.769	0.77	3.66	3.73
2600	3	3.01	−1.8°	0	0.385	0.386	3.66	3.67
5200	2.99	3	−3.6°	−5°	0.192	0.195	3.65	3.66
9100	2.98	3	−6.3°	−8°	0.101	0.107	3.63	3.66
14400	2.95	2.95	−10°	−12°	0.069	0.07	3.6	3.6
22200	2.9	2.92	−15.2°	−18°	0.045	0.049	3.54	3.56
39200	2.71	2.73	−25.6	−30°	0.025	0.25	3.3	3.33

Table 3

AC Source Frequency (Hz)	$X_L = \|V_L\|/\|I\|$ (peak/peak) (kΩ)		$\|Z\| = \|V_S\|/\|I\|$ (peak/peak) (kΩ)		$\measuredangle Z = \measuredangle V_S - \measuredangle I$ (degrees)	
	Theory	Meas.	Theory	Meas.	Theory	Meas.
700	0.007	0.007	0.82	0.816	-0.5°	0
1300	0.013	0.013	0.82	0.824	0.9°	0
2600	0.026	0.027	0.82	0.838	1.8°	0
5200	0.052	0.057	0.822	0.84	3.6°	5
9100	0.091	0.095	0.826	0.851	6.3°	8
14400	0.144	0.15	0.833	0.865	10°	12
22200	0.221	0.228	0.847	0.899	15°	18
39200	0.39	0.393	0.909	0.961	25.6°	30

12. Using the *measured* values in Table 3, plot (by hand) the following figures using the graph paper attached at the end of the report: (1) X_L and $|Z|$ on the same plot versus source frequency; (2) $\measuredangle Z$ versus source frequency; (3) V_L and V_R on the same plot versus source frequency.

13. For the above plots, state your conclusions under the plot?

15. Using the values in Table 4, plot (by hand) the following figure using the graph paper attached at the end of the report: P and Q on the same plot versus source frequency.

16. For the above plot, state your conclusions under the plot?

17. At what frequency the real power P is maximum? Why?
At 700 Hz, that because by increasing the frequancy the effect of real power will decrease according increasing in reactive power due to inductor effect.

18. At what frequency the magnitude of the reactive power $|Q|$ is maximum? Why?
At 39200 Hz, by increasing the frequancy the effect of inductor will increase so the reactive (imaginary) power will increase.

Table 4

AC Source Frequency (Hz)	$\|S\|$ (mVA)	$\measuredangle S$ (degrees)	P (mW)	Q (mVAR)	PF value	PF lead or lag
	Measured	Measured	Measured	Measured	Measured	Measured
700	5.74	0	5.74	0	1	in phase
1300	5.73	0	5.73	0	1	inphase
2600	5.64	0	5.64	0	1	inphase
5200	5.63	5°	5.61	0.49	0.996	lag
9100	5.7	8°	5.64	0.79	0.99	lag
14400	5.61	12°	5.49	1.17	0.978	lag
22200	5.7	18°	5.42	1.76	0.951	lag
39200	5.33	30°	4.62	2.67	0.866	lag

PROCEDURE B – AC-EXCITED PARALLEL RL CIRCUIT

Table 5

AC Source Frequency (Hz)	$V_{R'}$ (peak) (V)		$\angle V_{R'}$ with V_s (Lag = negative)		$V_R = V_L \approx V_S$ (peak) (V)		$\angle V_R$ with V_s (degrees)	
	Theory	Meas.	Theory	Meas.	Theory	Meas.	Theory	Meas.
810	2.313	2.3	−38.6°	−34.2°	3	1.9	0°	0°
1620	1.55	1.6	−57°	−52°	3	2.5	0°	0°
4100	0.7	0.72	−72°	−70°	3	2.8	0°	0°
5700	0.512	0.53	−73.8°	−68°	3	2.9	0°	0°
8100	0.365	0.39	−74.1°	−69°	3	2.92	0°	0°
11400	0.263	0.27	−72.5°	−67°	3	2.93	0°	0°
17900	0.174	0.16	−67.5°	−65°	3	2.94	0°	0°
30000	0.114	0.11	−57.7°	−55°	3	2.95	0°	0°

Table 6

AC Source Frequency (Hz)	I (peak) (mA) $= V_{R'}/R'$		$\angle I$ with V_s (Lag = negative)		I_R (peak) (mA) $= V_R/R$		$\angle I_R$ with V_s (degrees)	
	Theory	Meas.	Theory	Meas.	Theory	Meas.	Theory	Meas.
810	231.3	230	−38.6°	−34.2°	5.88	3.72	0°	0°
1620	155	160	−57°	−52°	5.88	4.9	0°	0°
4100	70	72	−72°	−70°	5.88	5.49	0°	0°
5700	50.12	53	−73.8°	−68°	5.88	5.69	0°	0°
8100	36.5	39	−74.1°	−69°	5.88	5.72	0°	0°
11400	26.3	27	−72.5°	−67°	5.88	5.75	0°	0°
17900	17.4	16	−67.5°	−65°	5.88	5.76	0°	0°
30000	11.4	11	−57.7°	−55°	5.88	5.78	0°	0°

Table 7

AC Source Frequency (Hz)	$I_L = I - I_R$ (mA) (magnitude (peak) and phase (degrees)) (phasor subtraction)	
	Theory	Measured
810	226.7 ∠ −39.5°	226.93 ∠ −34.7°
1620	151.88 ∠ −58.9°	157.03 ∠ −53.4°
4100	68.4 ∠ −76.7°	70.31 ∠ −74.2°
5700	48.8 ∠ −80.4°	51.14 ∠ −73.92
8100	35.3 ∠ −83.3°	37.33 ∠ −77.22°
11400	25.2 ∠ −85.4°	25.31 ∠ −79.1°
17900	16.1 ∠ −87.2°	14.54 ∠ −86°
30000	9.64 ∠ −88.7°	9.03 ∠ −86.6°

8. Can we just subtract the magnitudes of $|I| - |I_R|$ to obtain the magnitude $|I_L|$? Why or why not?

....NO, because ~~it~~ they are a vector quantity.....

Table 8

AC Source Frequency (Hz)	$B_L = \|I_L\|/\|V_L\|$ (peak/peak) (mS)		$\|Y\| = \|I\|/\|V_S\|$ (peak/peak) (mS)		$\measuredangle Y = \measuredangle I - \measuredangle V_S$ (degrees)	
	Theory	Meas.	Theory	Meas.	Theory	Meas.
810	75.57	119.44	77.1	121.05	$-38.6°$	$-34.2°$
1620	50.63	62.81	51.67	64	$-57°$	$-52°$
4100	22.8	25.11	23.33	25.71	$-72°$	$-70°$
5700	16.27	17.63	16.71	18.28	$-73.8°$	$-68°$
8100	11.77	12.78	12.17	13.36	$-74.1°$	$-69°$
11400	8.4	8.63	8.77	9.21	$-72.5°$	$-67°$
17900	5.37	4.95	5.8	5.44	$-67.5°$	$-65°$
30000	3.21	3.06	3.8	3.73	$-57.7°$	$-55°$

10. Using the *measured* values in Table 8, plot (by hand) the following figures using the graph paper attached at the end of the report: (1) B_L and $|Y|$ on the same plot versus source frequency; (2) $\measuredangle Y$ versus source frequency; (3) I_L and I_R on the same plot versus source frequency.

11. For the above plots, state your conclusions under the plot?

Table 9

AC Source Frequency (Hz)	$\|S\|$ (mVA)	$\measuredangle S$ (degrees)	P (mW)	Q (mVAR)	PF value	PF lead or lag
	Measured	Measured	Measured	Measured	Measured	Measured
810	345	$-34.2°$	285.34	193.92	0.827	lead
1620	240	$-52°$	147.76	189.12	0.616	lead
4100	108	$-70°$	36.94	101.49	0.342	lead
5700	79.5	$-68°$	29.78	73.71	0.375	lead
8100	58.5	$-69°$	20.96	54.61	0.358	lead
11400	40.5	$-67°$	15.82	37.28	0.391	lead
17900	24	$-65°$	10.14	21.75	0.423	lead
30000	16.5	$-55°$	9.46	13.52	0.574	lead

lagging

13. Using the values in Table 9, plot (by hand) the following figure using the graph paper attached at the end of the report: P and Q on the same plot versus source frequency.

14. For the above plot, state your conclusions under the plot?

15. At what frequency the real power P is maximum? Why?

At 810 Hz while the frequency is small ~~the effect of inductor is small~~.
$f\downarrow$ $X_L\downarrow$ $Z\downarrow$ $I\uparrow$ V_s constant so $P\uparrow$ $(P=\frac{1}{2}IV_s\cos\theta)$.

16. At what frequency the magnitude of the reactive power $|Q|$ is maximum? Why?

At 810 Hz, while decreasing the frequancy $f\downarrow$ $X_L\downarrow$ $Z\downarrow$ $I\uparrow$ V_s constant so $Q\uparrow$ $\downarrow$ $\frac{1}{2}IV_s\sin\theta$

CONCLUSIONS

Summarize in clear but concise format what you learned from this experiment:

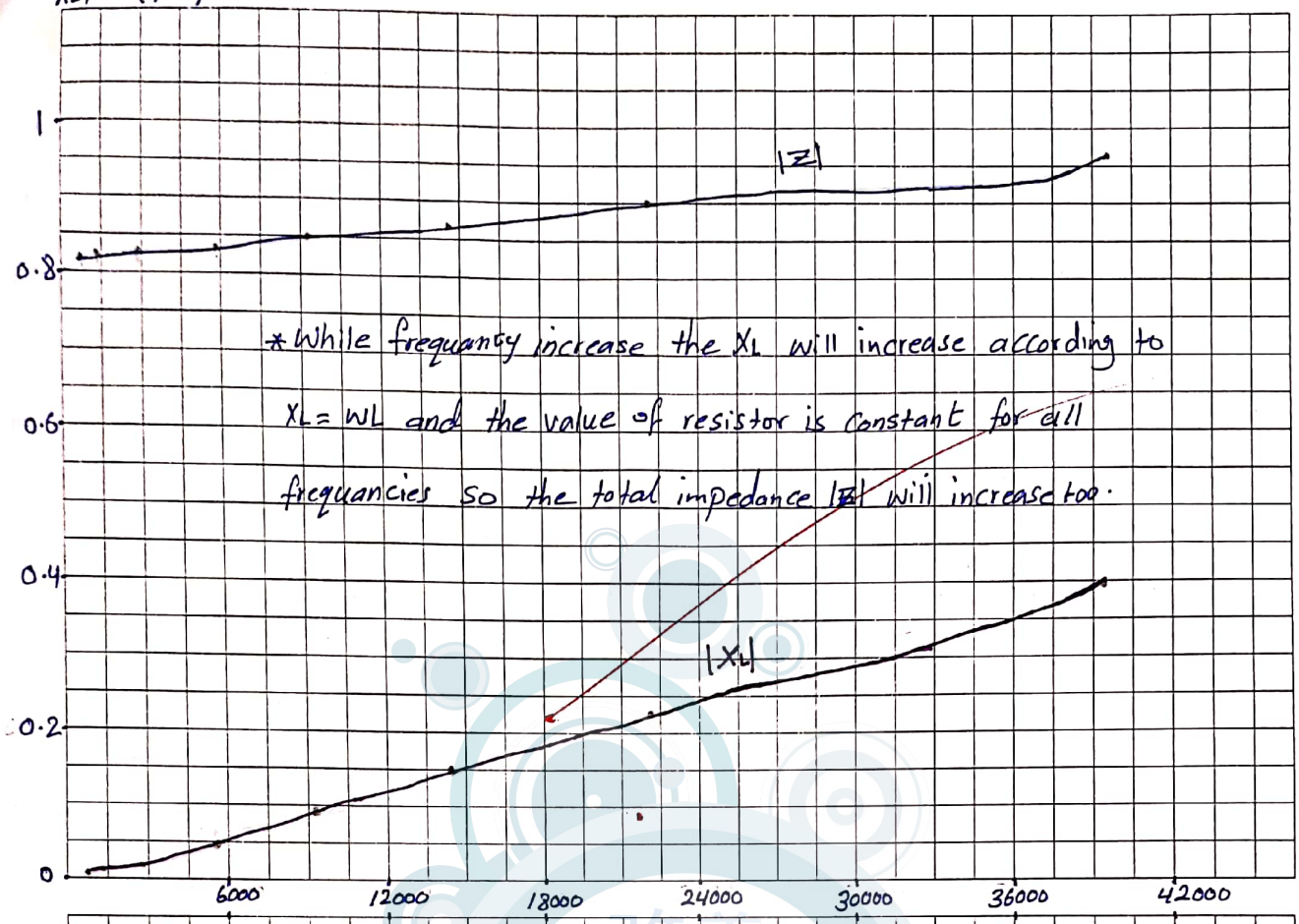
we learned how to connect the inductor in parallel and in series with other circuit components then how to measure the voltage and currents for each component and know the effect of changing frequancy on all of them then practice more and more on theoritical analysis.

Also, find and calculate the related other calculations and value like real power, reactive power, power factor, angles,...

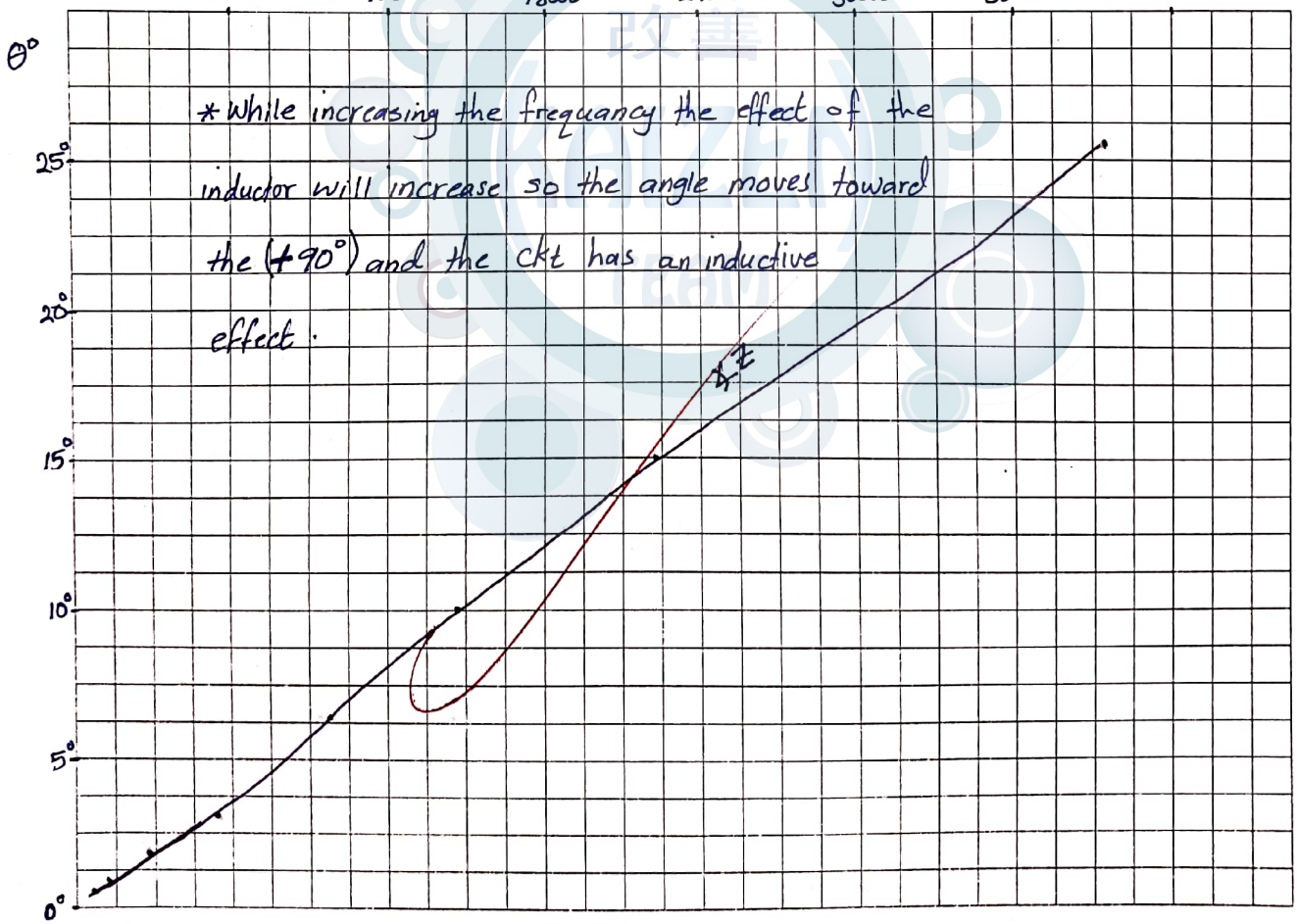
finally, how to plot the relations between several factors and conclude the relation between them.

** End **

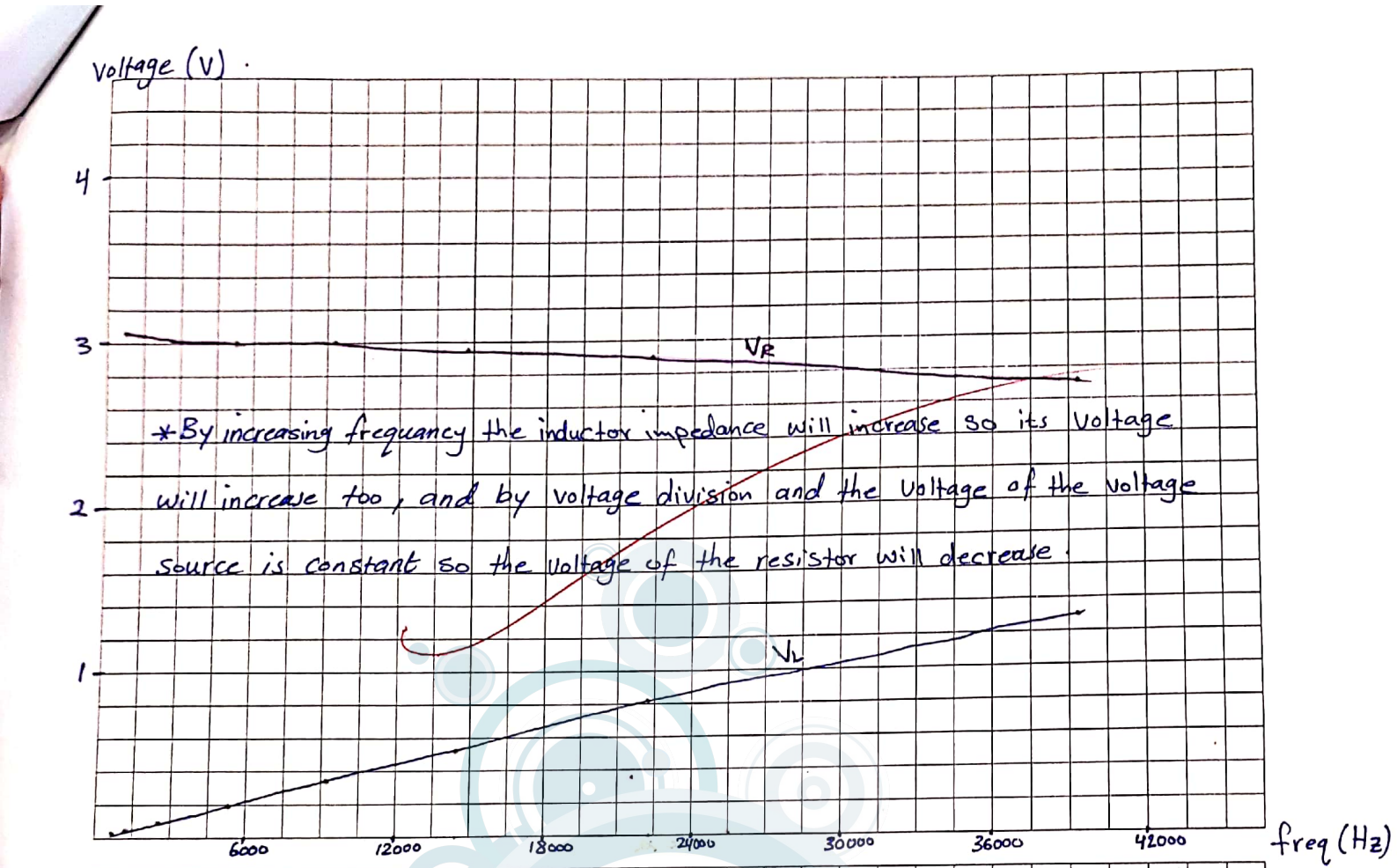
X_L, Z (KΩ).



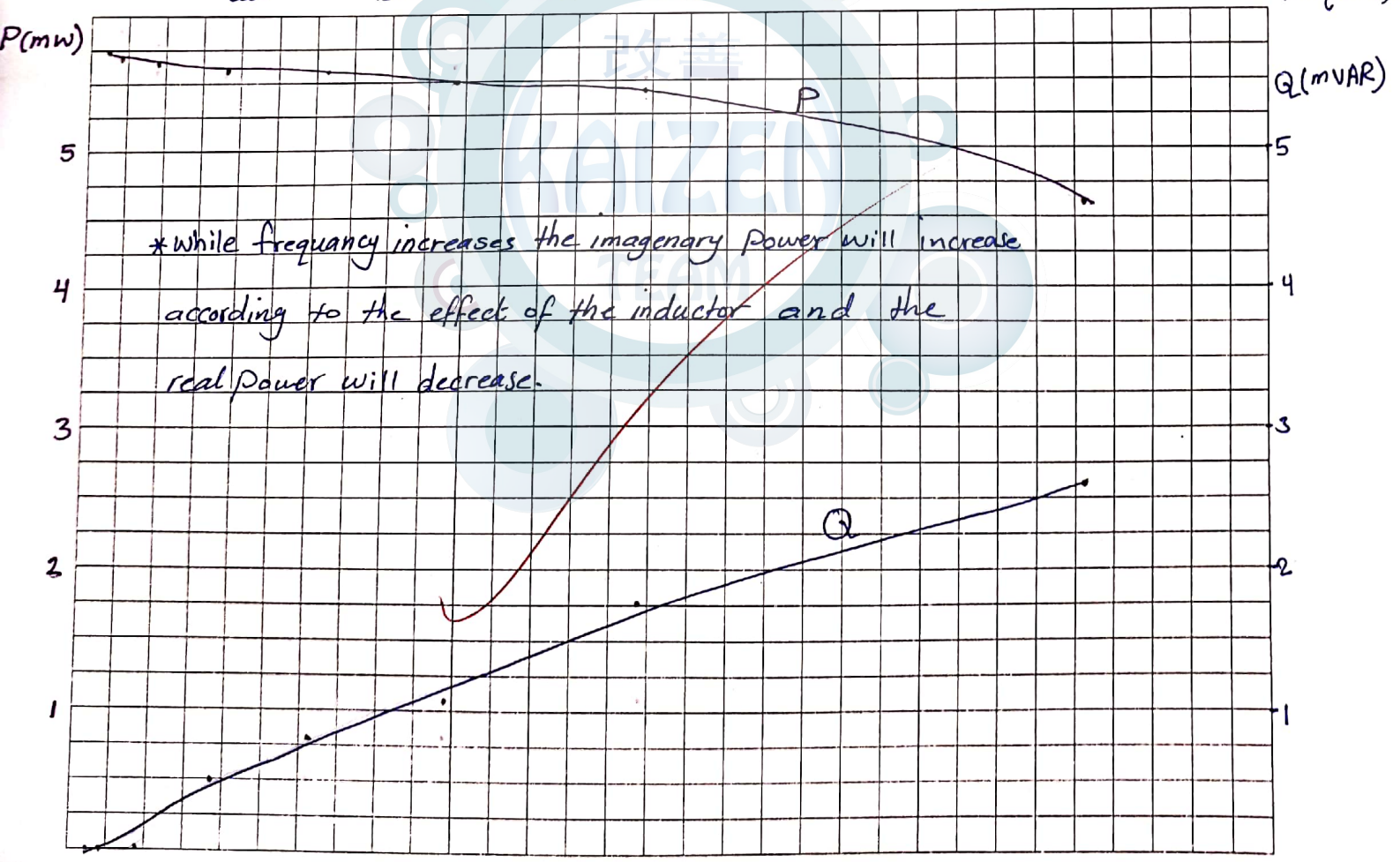
* While frequancy increase the X_L will increase according to $X_L = WL$ and the value of resistor is constant for all frequancies so the total impedance |Z| will increase too.



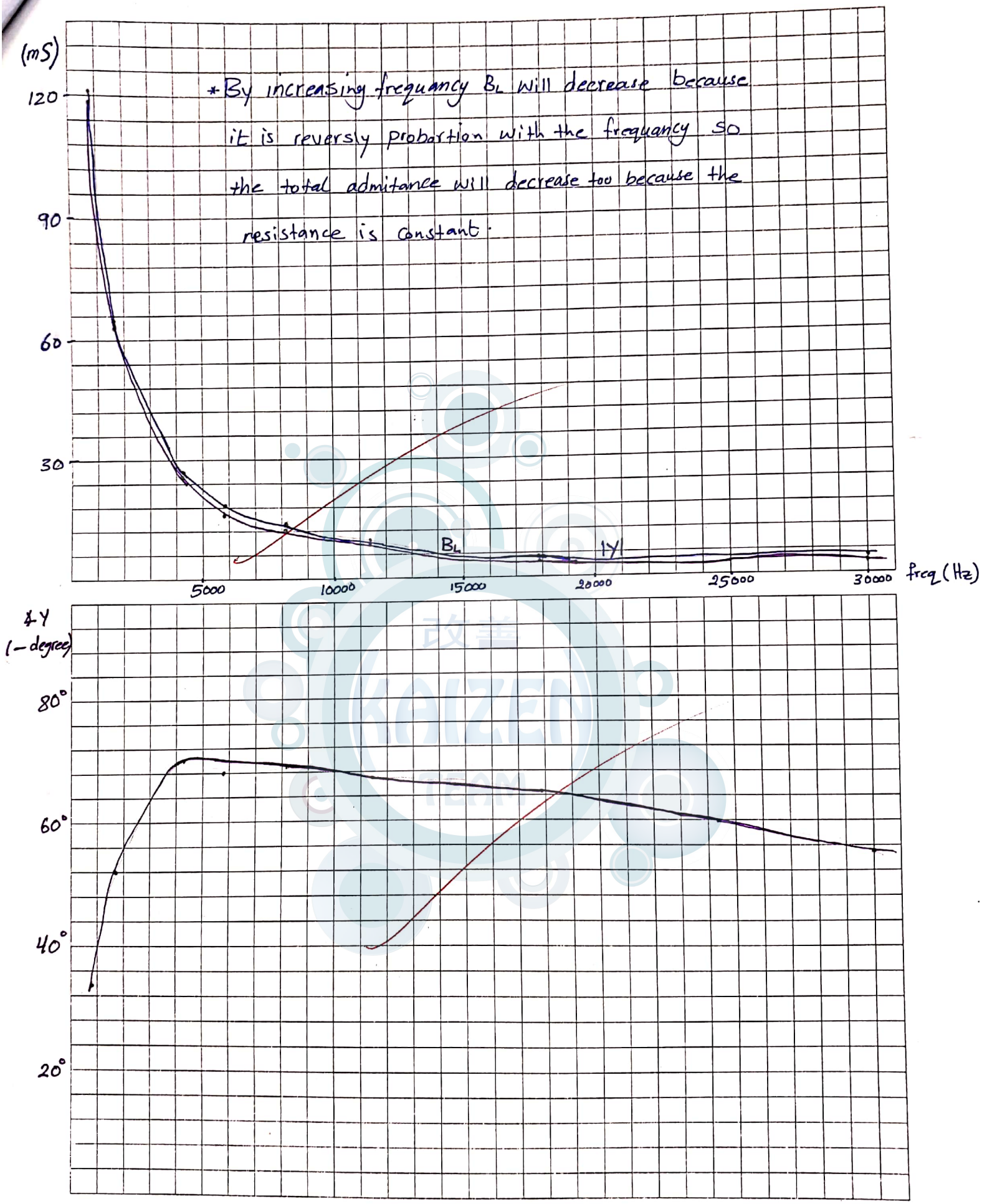
* While increasing the frequancy the effect of the inductor will increase so the angle moves toward the (+90°) and the ckt has an inductive effect.

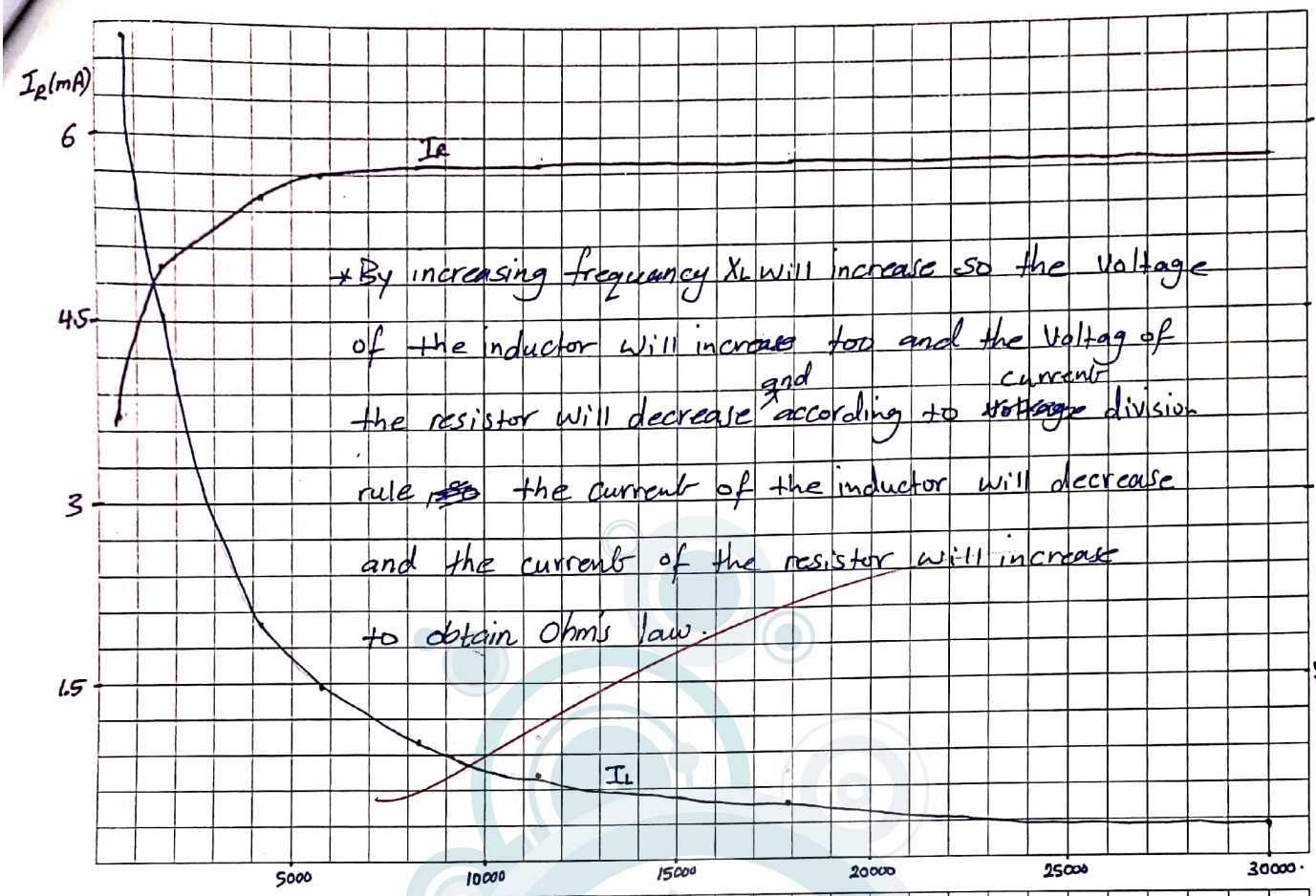


*By increasing frequancy the inductor impedance will increase so its voltage will increase too, and by voltage division and the voltage of the voltage source is constant so the voltage of the resistor will decrease.

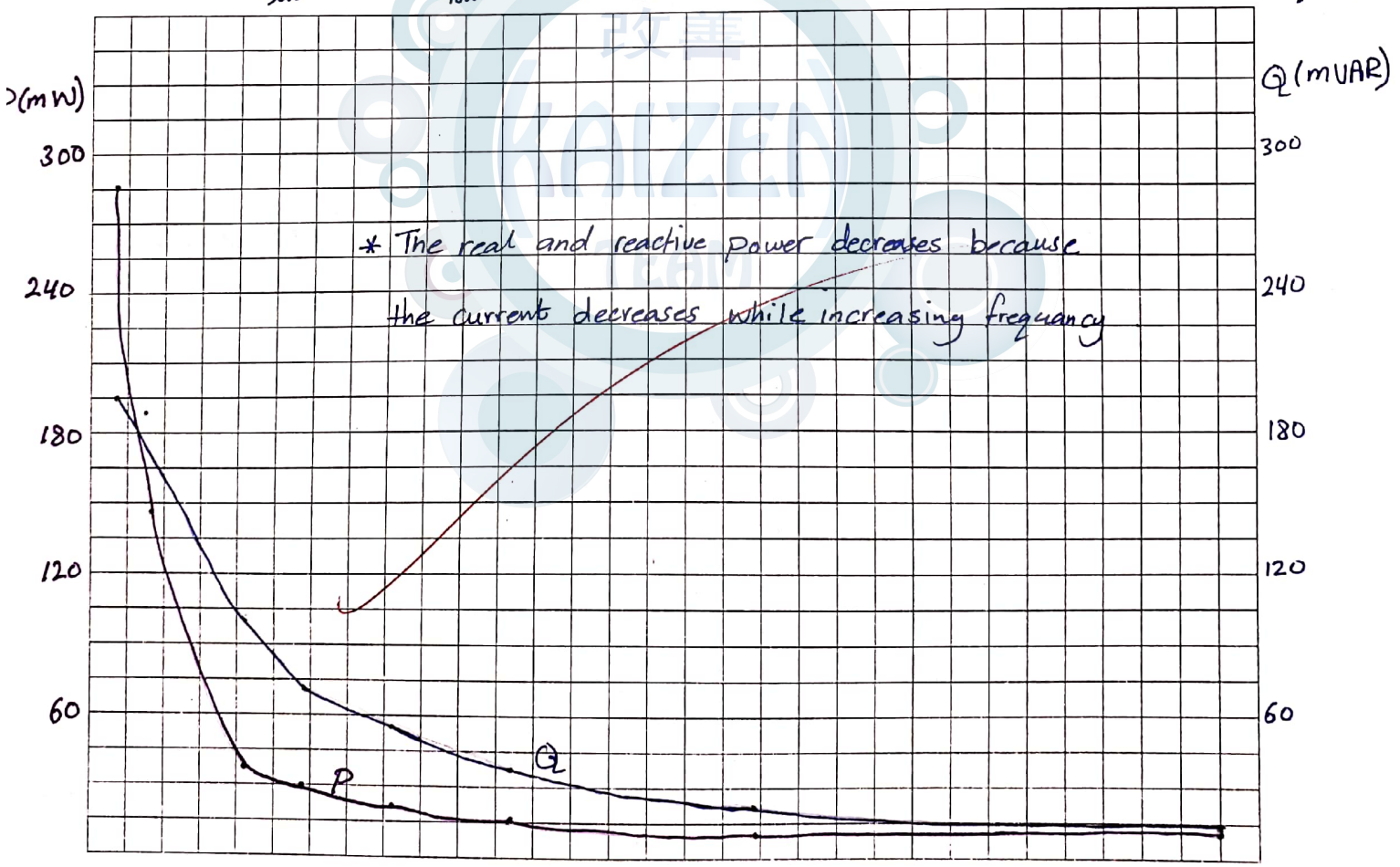


*while frequancy increases the imagenary power will increase according to the effect of the inductor and the real power will decrease.





*By increasing frequency X_L will increase so the voltage of the inductor will increase too and the voltag of the resistor will decrease and according to current division rule the current of the inductor will decrease and the current of the resistor will increase to obtain Ohm's law.



* The real and reactive power decreases because the current decreases while increasing frequancy