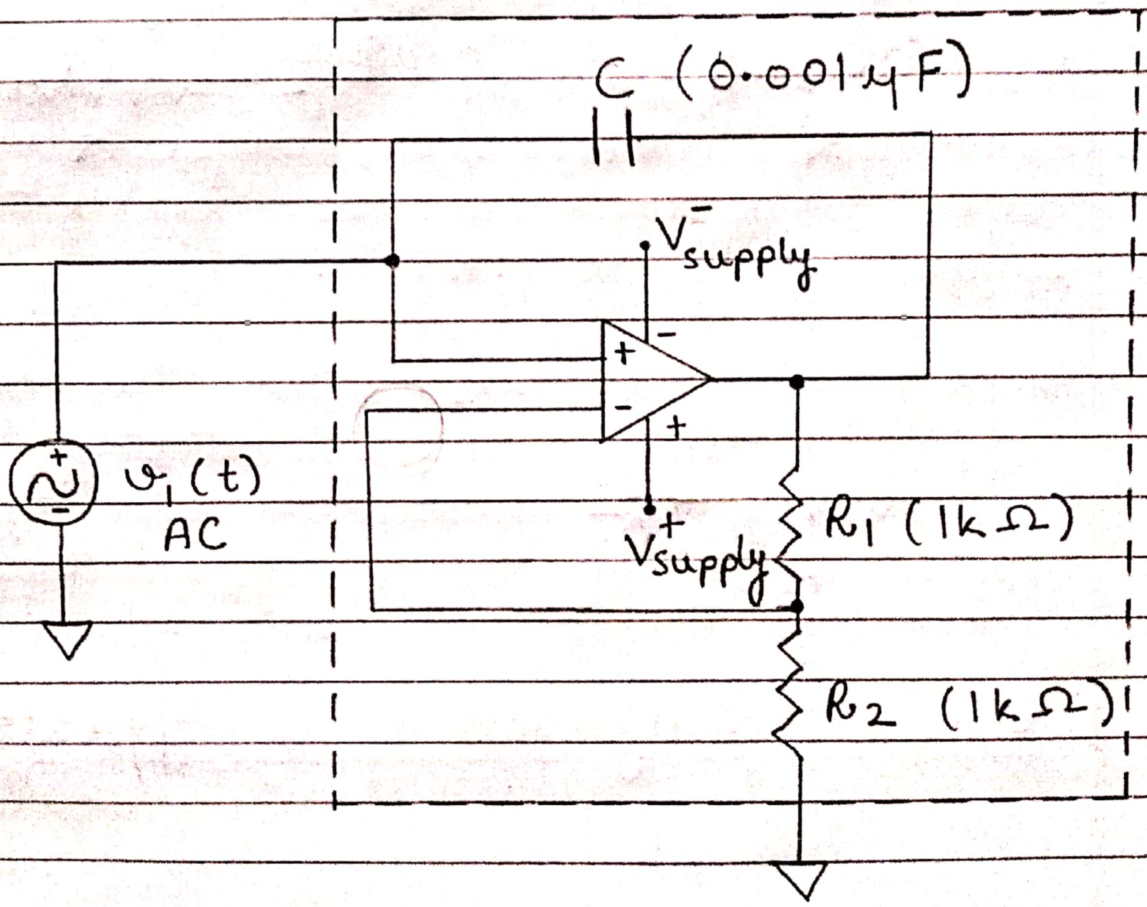
Negative Impedance Convertor

Circuit Diagram :



Negative Impedance Convertor

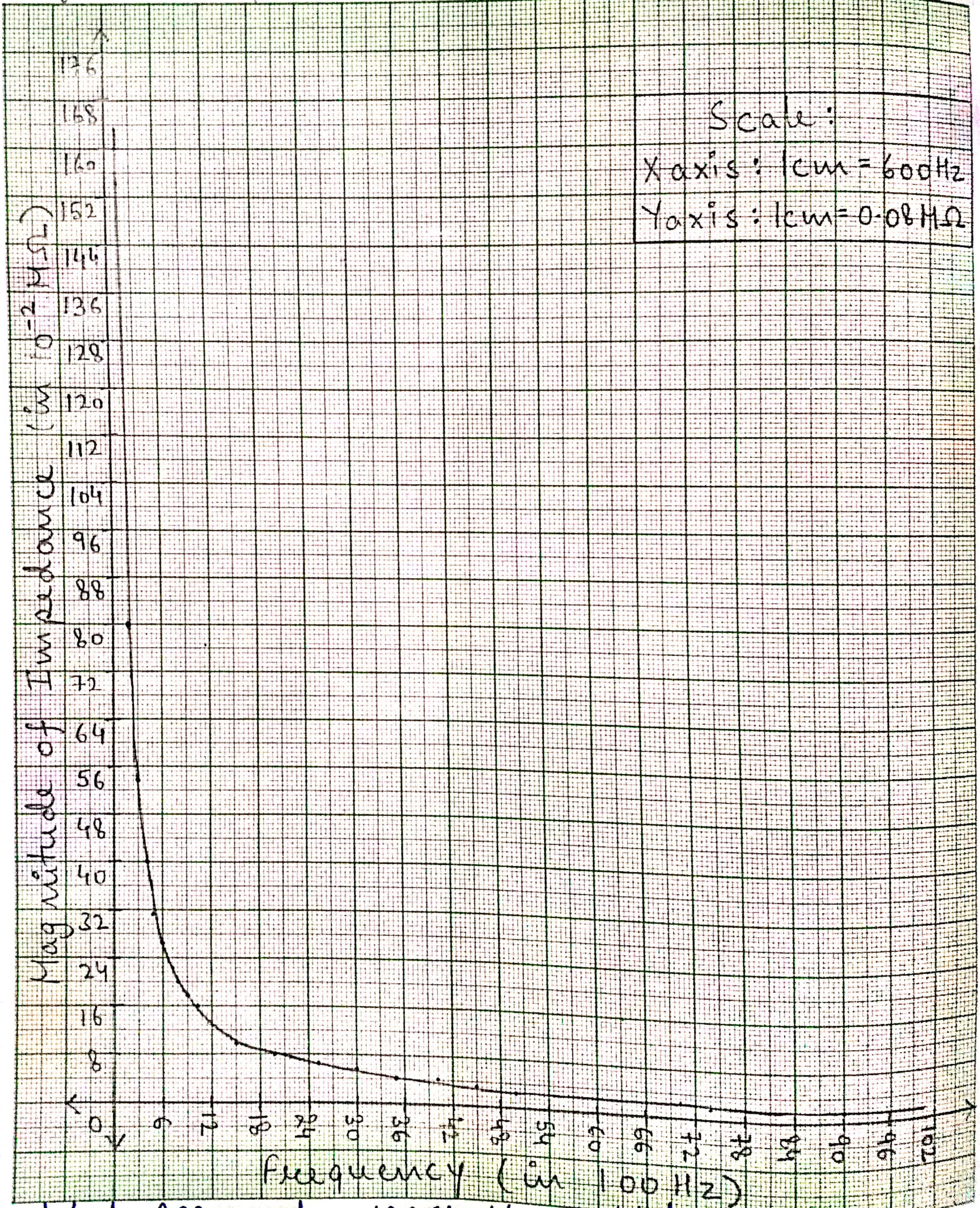
Nakul Aggarwal 19CS10044 Nakul

PAGE NO.:
DATE: / /

Observation Table:

Frequency (Hz)	Voltage Magnitude (Volts)	Current Amplitude (μA)	Phase of I wrt V	Complex Impedance (Mohm)
100	1	0.6259	−90°	1.5977 j
200	1	1.2531	−90°	0.7980 j
300	1	1.8703	−90°	0.5347 j
400	1	2.5131	−90°	0.3979 j
500	1	3.1418	−90°	0.3183 j
600	1	3.7650	−90°	0.2656 j
700	1	4.3969	−90°	0.2274 j
800	1	5.0239	−90°	0.1990 j
900	1	5.6521	−90°	0.1769 j
1k	1	6.2784	−90°	0.1593 j
1.5k	1	9.4108	−90°	0.1063 j
2k	1	12.5345	−90°	0.0798 j
2.5k	1	15.6443	−90°	0.0639 j
3k	1	18.7050	−90°	0.0535 j
3.5k	1	21.9835	−90°	0.0455 j
4k	1	25.1310	−90°	0.0398 j
4.5k	1	28.2678	−90°	0.0354 j
5k	1	31.4120	−90°	0.0318 j
5.5k	1	34.5313	−90°	0.0289 j
6k	1	37.6744	−90°	0.0265 j
6.5k	1	40.8310	−90°	0.0245 j
7k	1	43.9673	−90°	0.0227 j
7.5k	1	47.0913	−90°	0.0212 j
8k	1	50.2340	−90°	0.0199 j
8.5k	1	53.3234	−90°	0.0188 j
9k	1	56.4630	−90°	0.0177 j
9.5k	1	59.6085	−90°	0.0168 j
10k	1	62.7810	−90°	0.0159 j

Negative Impedance Convertor - Plot A.



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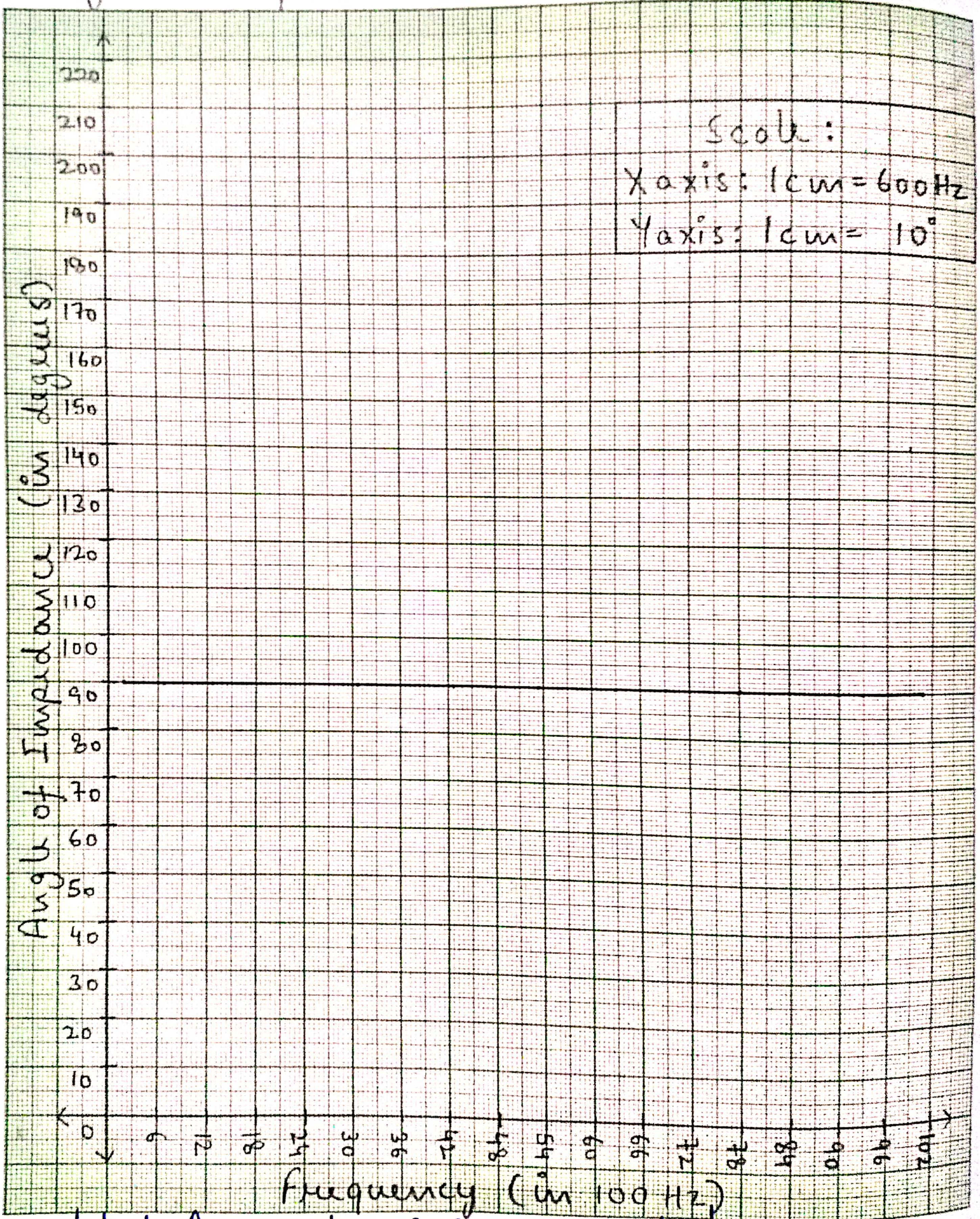
Negative Impedance Converter – Plot B



Nakul Aggarwal 19CS10044 Nakul

Nakul Aggarwal 19CS10044 Nakul

PAGE NO.:
DATE: / /

Discussion Question:

Q Comment whether you can create an inductor using a capacitor (or vice-versa) using this negative impedance convertor.

Ans. A negative impedance convertor only produces the "negative" of an impedance. Like, for a capacitor the complex impedance is negative ($-|X_c|j$) and for an inductor it is positive ($+|X_L|j$). Another characteristic of a capacitor is that its reactance is inversely proportional to the frequency; whereas for an inductor the reactance is directly proportional to frequency. Therefore, despite of being able to make the angle of capacitive impedance same as that of an inductor's impedance by using a negative impedance convertor, its response to the change in frequency will remain intact, i.e., its magnitude will still decrease with increase in frequency which is opposite to the case for inductors. Hence, an inductor cannot be created by using a capacitor (by vice-versa) in a negative impedance convertor.

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16/11/20

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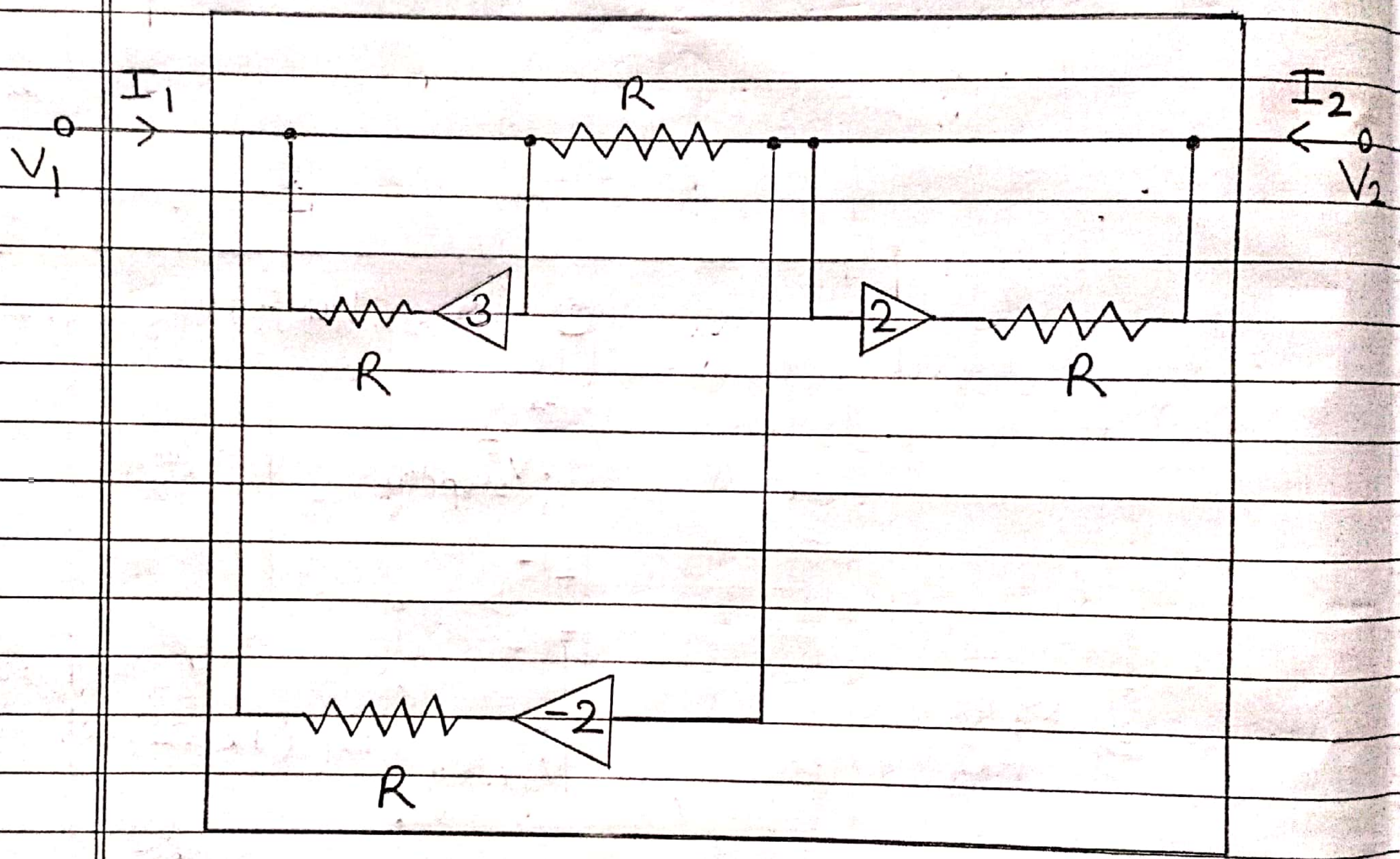
Gyrator

Circuit Diagram:



Circuit Diagram of a Gyrator

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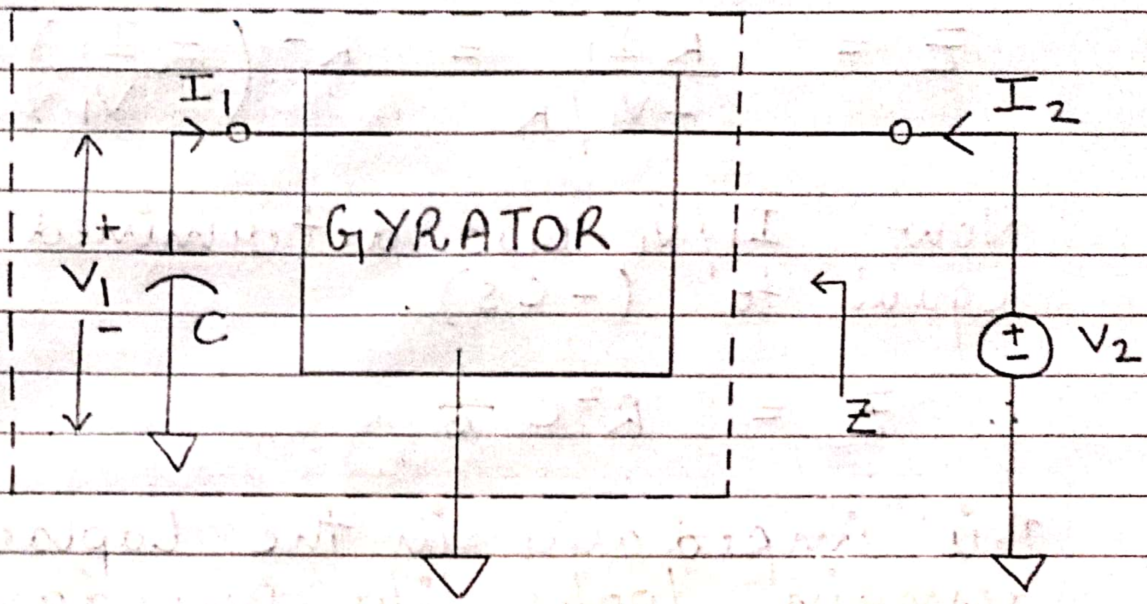
Derivation:



A gyrator is a linear two port device which couples the current on one port to the voltage on the other and vice versa. The currents and voltages are hence related by

$$V_2 = R I_1 , \quad V_1 = -R I_2$$

(where R is the gyration resistance of the gyrator).

In laplace domain, I_1 and V_1 in the above network can be related as

$$V_1 = -I_1 (1/Cs)$$

Now the impedance Z as seen from the output side will be :-

$$Z = \frac{V_2}{I_2}$$

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Put $V_2 = R I_1$ and $I_2 = -V_1/R$

$$Z = \frac{R I_1}{-V_1/R} = R^2 \left(- \frac{I_1}{V_1} \right)$$

Now I_1/V_1 was determined to be equal to $(-cs)$.

$$\therefore \quad Z = R^2 C s$$

This impedance in the Laplace domain looks like impedance of and inductor whose inductance L is equal to $R^2 C$.

Therefore, like this using the two port network representation of a gyrator, an inductor can be simulated using a capacitor.

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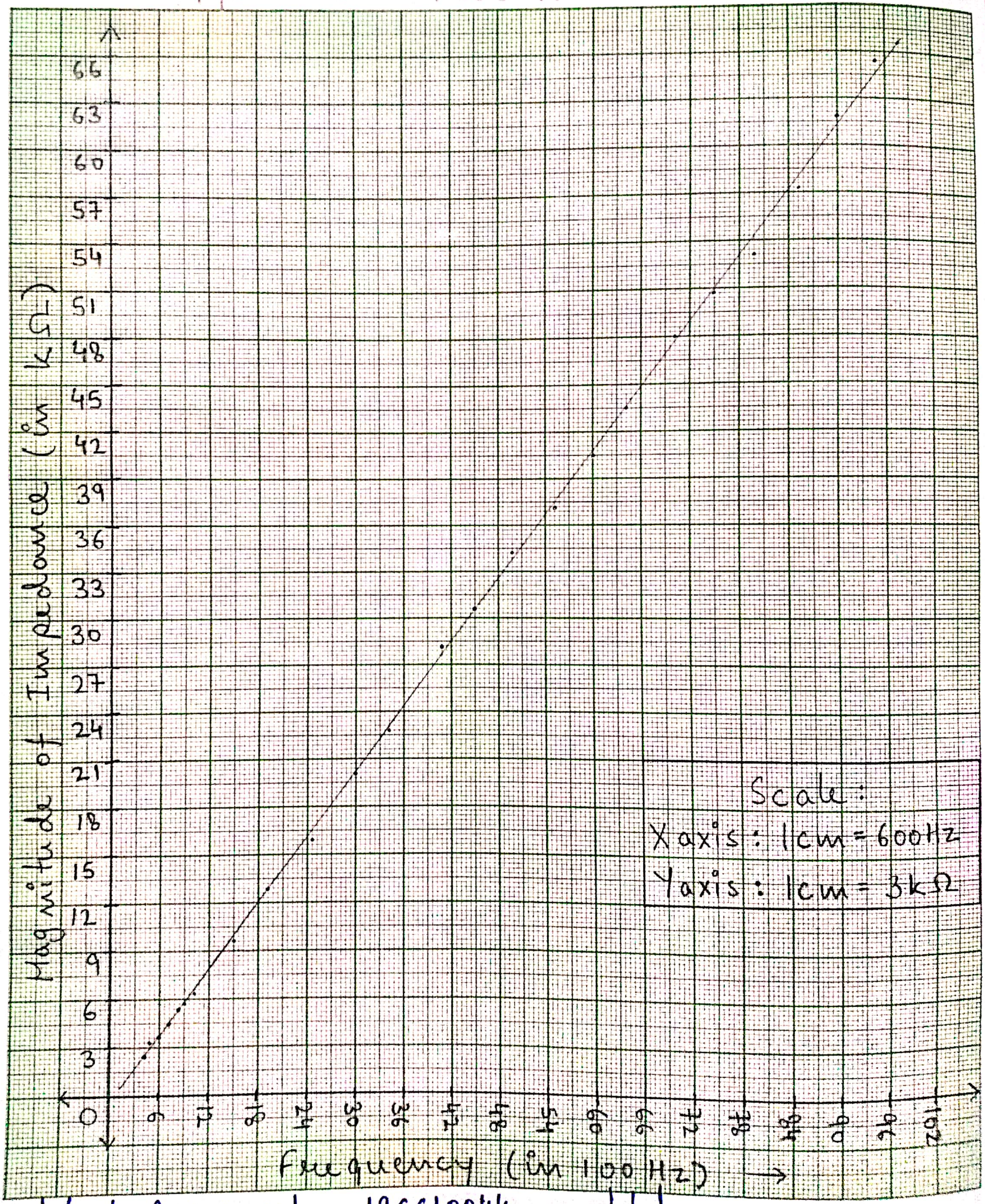
Observation Table:

Frequency (Hz)	Voltage Magnitude (Volts)	Current Amplitude (μA)	Phase of I wrt V	Complex Impedance (k-ohm)
400	1	396.361	-90°	2.523j
500	1	317.755	-90°	3.147j
600	1	264.620	-90°	3.779j
700	1	226.912	-90°	4.407j
800	1	198.463	-90°	5.039j
900	1	176.538	-90°	5.664j
1k	1	158.850	-90°	6.295j
1.5k	1	105.770	-90°	9.454j
2k	1	79.158	-90°	12.633j
2.5k	1	63.194	-90°	15.824j
3k	1	52.875	-90°	18.912j
3.5k	1	45.279	-90°	22.085j
4k	1	39.576	-90°	25.268j
4.5k	1	35.139	-90°	28.458j
5k	1	31.576	-90°	31.670j
5.5k	1	28.649	-90°	34.905j
6k	1	25.939	-90°	38.552j
6.5k	1	23.869	-90°	41.895j
7k	1	22.381	-90°	44.681j
7.5k	1	20.679	-90°	48.359j
8k	1	19.217	-90°	52.038j
8.5k	1	17.948	-90°	55.716j
9k	1	16.837	-90°	59.394j
9.5k	1	15.855	-90°	63.073j
10k	1	14.981	-90°	66.751j

Gyrator – Plot A



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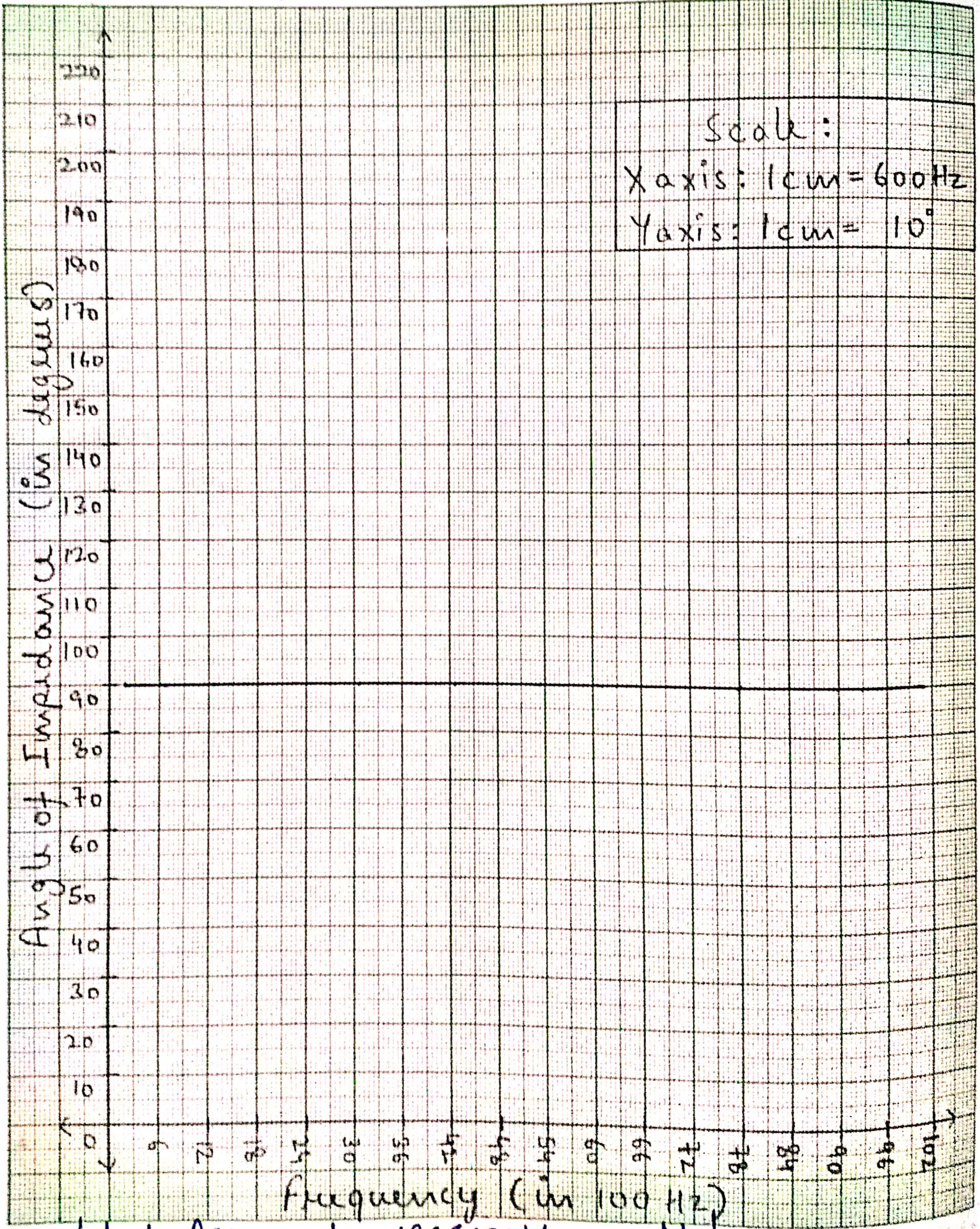
Gyrator – Plot B



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