Eray Gündoğdu

Section-02

EEE202 CIRCUIT THEORY LAB3 REPORT

Purpose:

Aim of this experiment is to design two passive linear circuits that transfers maximum power to the 220Ω load from a voltage souce with 50Ω internal serial resistance and 7MHz frequency.

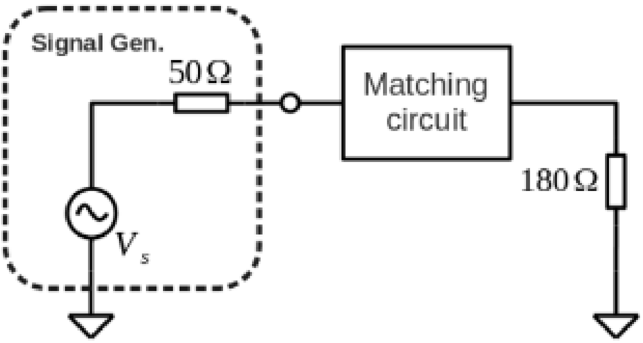

Fig1.1 The given task

Methadology:

In order to obtain maximum power transfer between source and the load, the relation between source impedance(Z_s) should be the complement of load impedance(Z_l).Mathematically meaning that $Z_s = Z_l^*$.In this case, transfered power can be obtained with the following calculations.

$$P_{ave} = I^2 * \frac{Z_l + Z_s}{2}$$

$$I = \frac{V_s}{Z_l + Z_s}$$

$$P_{ave} = (\frac{V_s}{Z_l + Z_s})^2 * \frac{Z_l + Z_s}{2}$$

$$Z_s = Z_l^* = R$$

$$P_{ave} = \frac{(V_s)^2}{8R}$$

There are various ways to obtain maximum power transfer.In this lab assignment the maximum power transfer is obtained by using L-section and π-section method.

L-section Method:

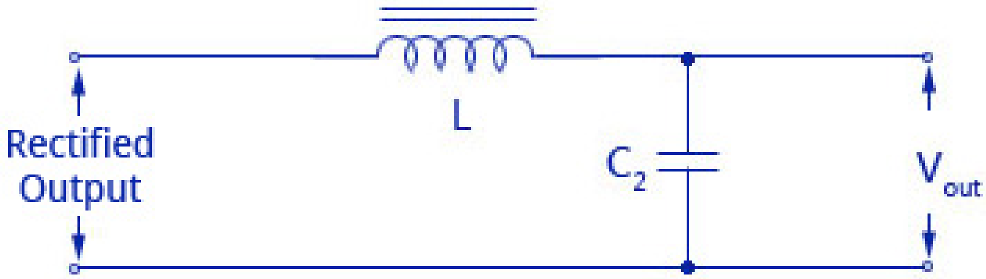

Fig1.2 L-section circuit

Capacitor and inductance values can be found accordingly:

$$R_p = 180\Omega, R_s = 50\Omega, f = 7MHz$$

$$R_p = (Q^2 + 1) * R_s$$

$$Q = 1.6124$$

$$Q = \frac{\omega * L_s}{R_s} = \frac{2 * \pi * f * L_s}{R_s}$$

$$L_s \sim 1.8\text{mH}$$

$$2 * \pi * f = \sqrt{\frac{1}{C * L_s(1 + \frac{1}{Q^2})}}$$

$$C \sim 174\text{pF}$$

π-section Method:

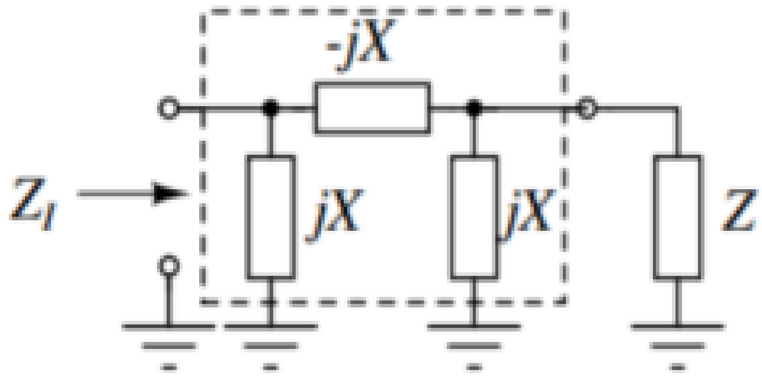

Fig1.3 T-section circuit

According to this schematic Z is the load impadence and Z_l is the source impedance.In this lab assignment $Z = 180\Omega$ and Z_l = 50Ω.Inductance and capacitor values for the π-section method can be found with the following calculations:

$$Z_l = (\frac{1}{\left(\frac{1}{jX} + \frac{1}{Z}\right)^{-1} - jX} + \frac{1}{jX})^{-1} = \frac{X^2}{Z}$$

$$X = \pm\sqrt{Z_l * Z}$$

$$X = \pm 94.86\Omega$$

$$jX = \frac{1}{2\pi f * C * j}$$

$$-jX = \frac{1}{2\pi f * C * j}$$

$$C \sim 239\text{pF}$$

$$-jX = j * 2\pi f * L$$

$$L \sim 2.16\mu\text{H}$$

Software Part:

The calculated values of inductors and capacitors are entered to the established circuit in LTSpice.Software circuits and results are as following:

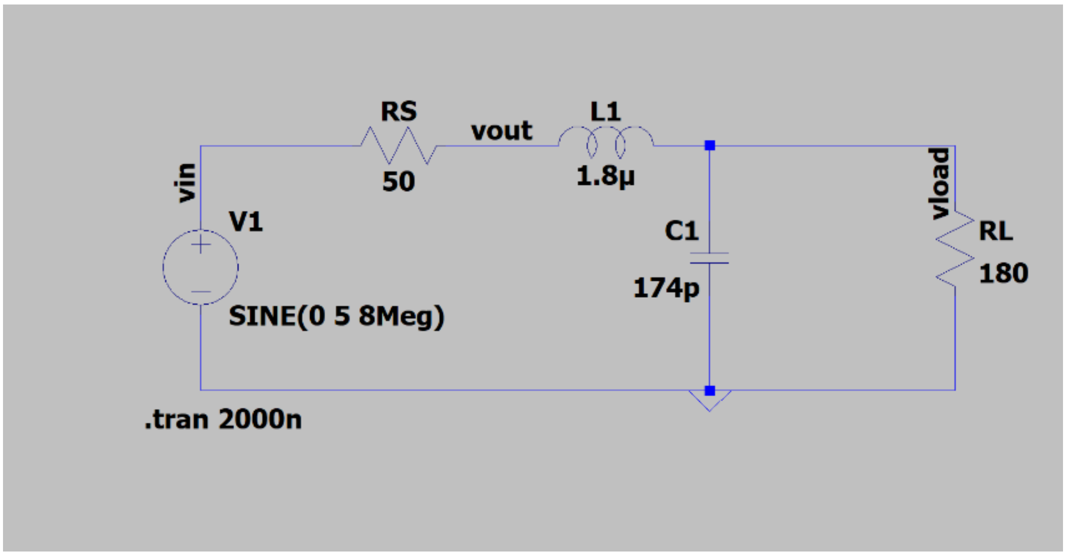

Fig2.1 L-seFction circuit

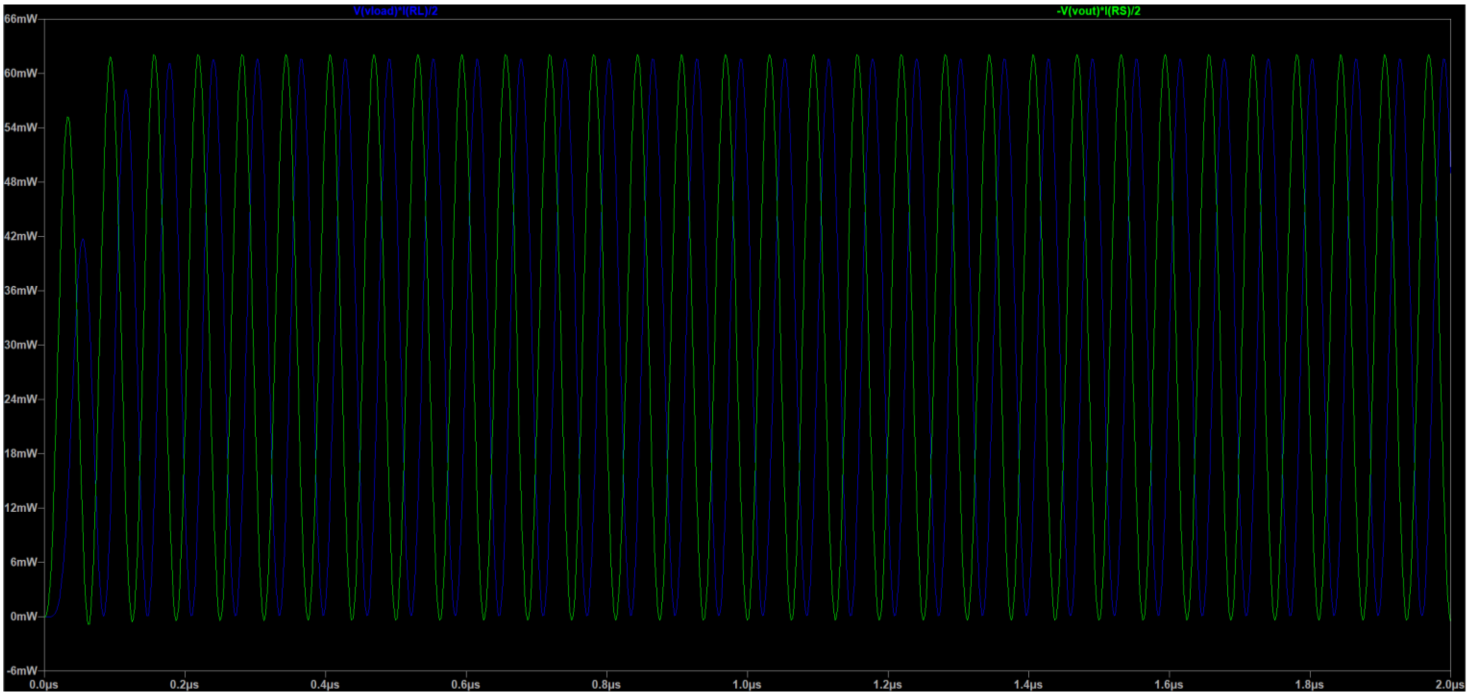

Fig2.2 demonstration of power transfer with L-section

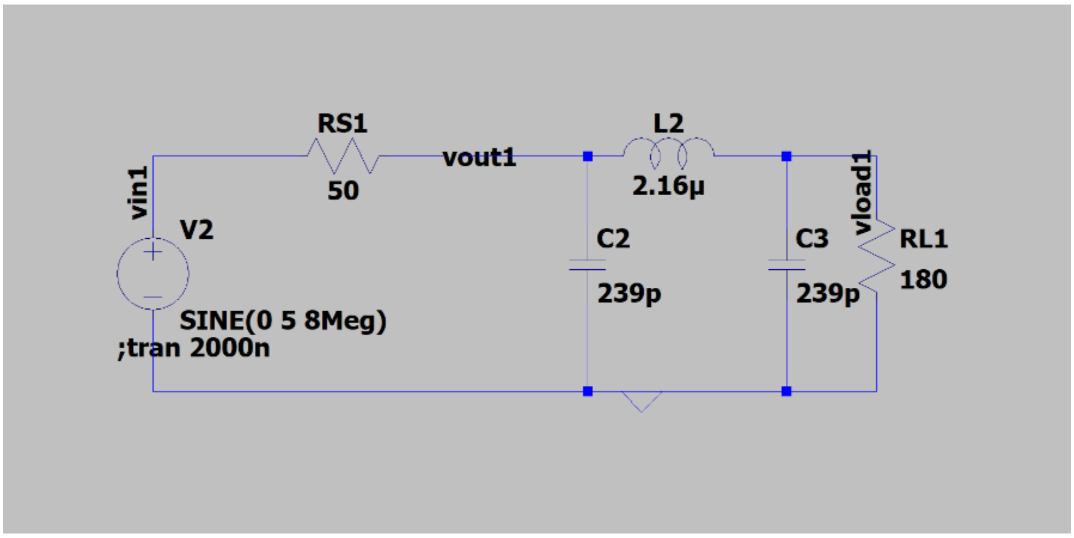

Fig2.3 π-section circuit

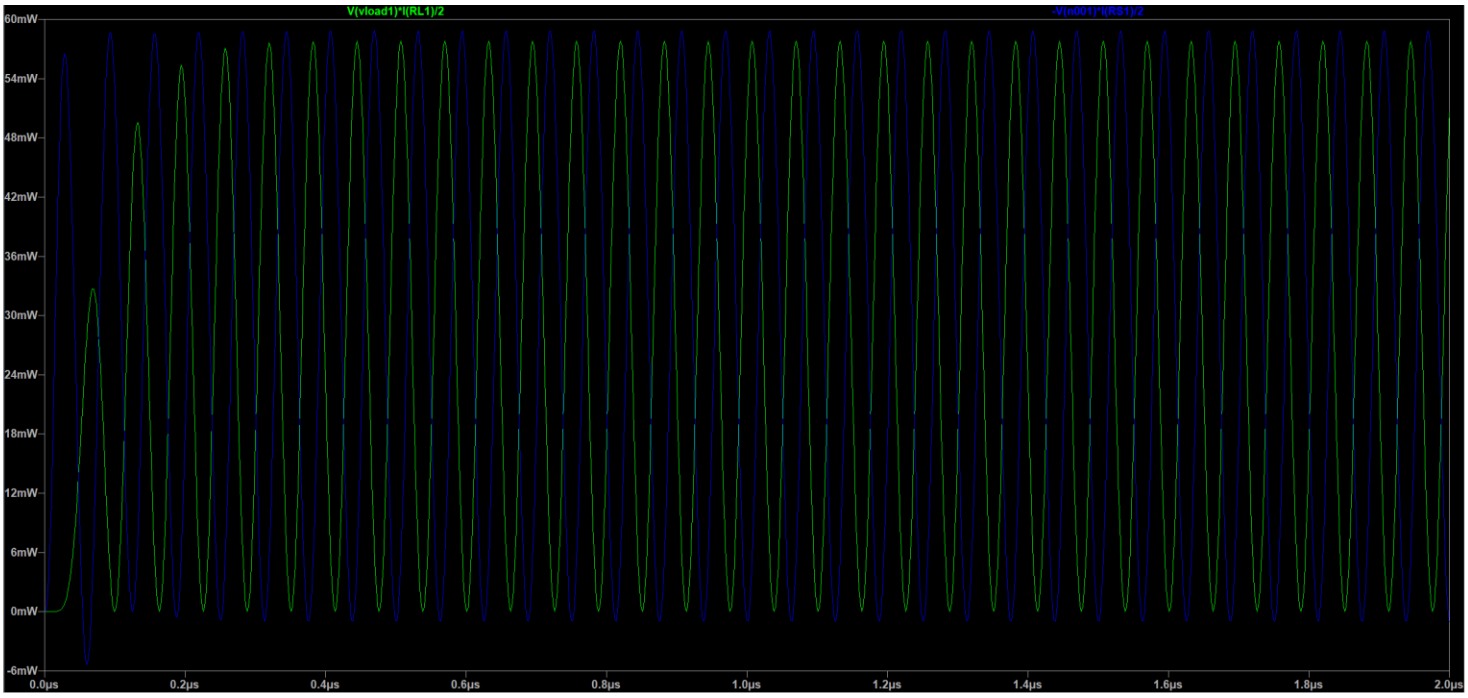

Fig 2.4 demonstration of power transfer with π-section

We obtained that:

$$P_{ave} = \frac{(V_s)^2}{8R}$$

$$V_s = 5V, R = 50\Omega$$

$$P_{ave} = 62.5mW$$

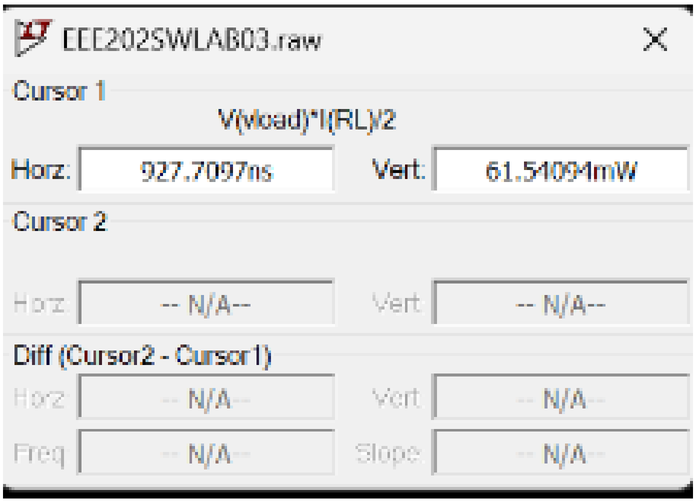

Fig2.4 software result of average power for L-section

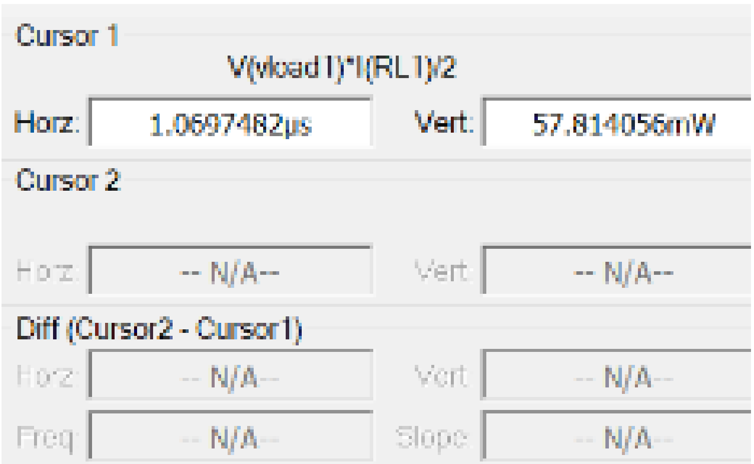

Fig2.4 software result of average power for π-section

The simulation error is whithin the error band which means that circuits are working as desired.

Hardware part:

In this part of the lab the calculated inductor values are obtained by serially connecting inductors which has smaller value compared to calculated values.The implementation of circuits can be seen as following:

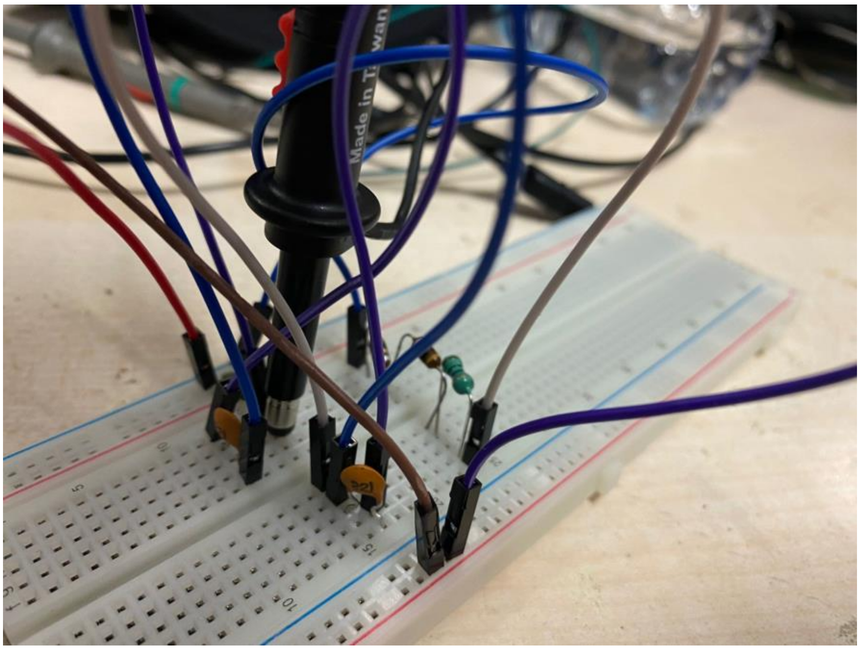

Fig3.1 implementation of π-section

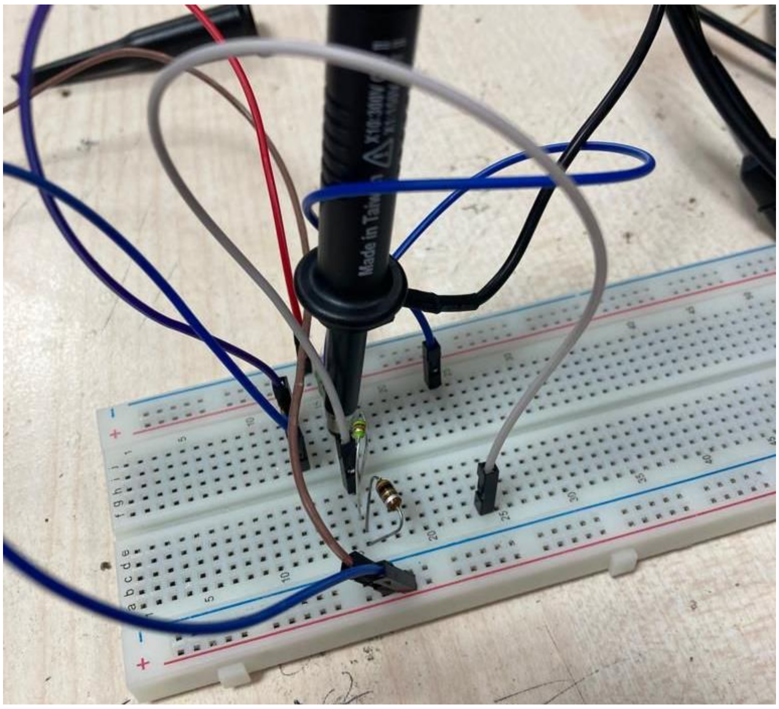

Fig3.2 implementation of L-section

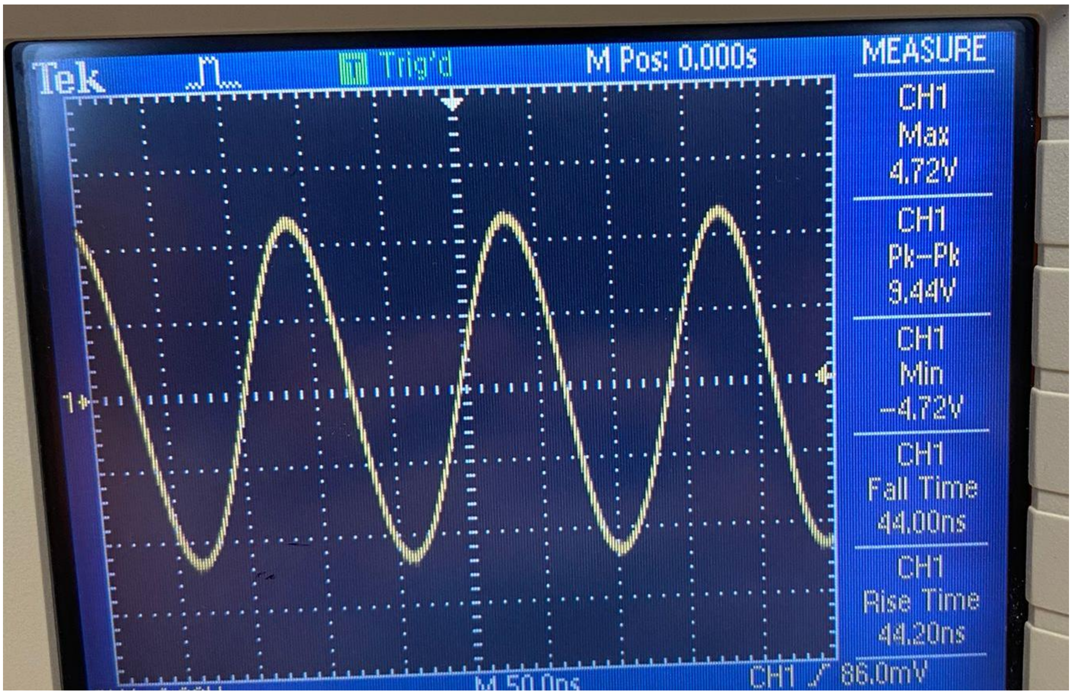

Fig3.3 hardware result of peak to peak voltage among the load in π-section

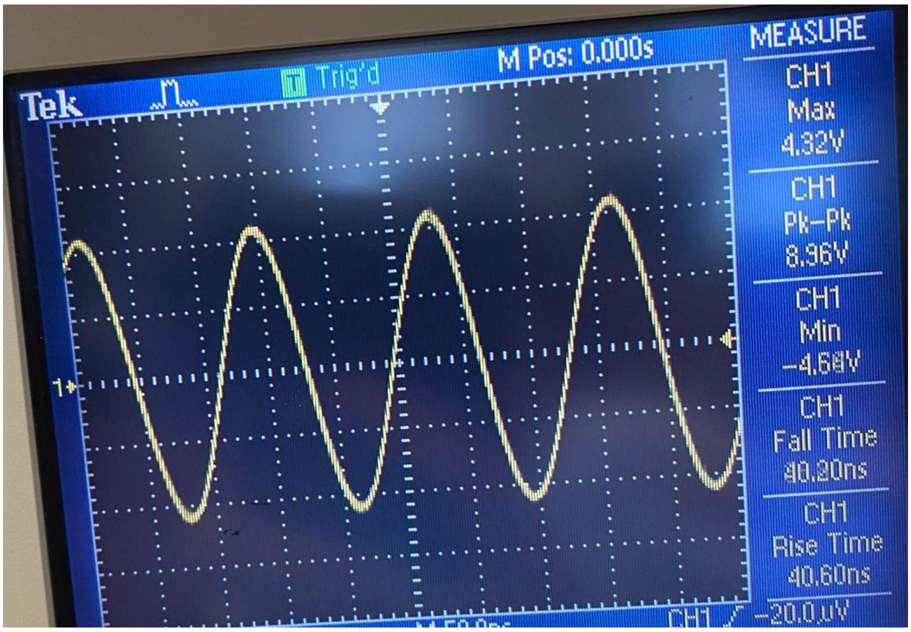

Fig3.4 hardware result of peak to peak voltage among the load in L-section

Values for π-section:

	Calculated	Software	Hardware
P_{ave}	62.5 mW	57.8 mW	55.6 mW

Values for L-section:

	Calculated	Software	Hardware
P_{ave}	62.5 mW	61.5 mW	56.6 mW

Conclusion:

This experiment provided a better understanding of power transfer methods.There are slight differences between the results due to connecting three inductors to obtain one value,uncertainity of oscilloscope and power supply,resistance occured due to jumper cables and human error.These differences can be neglected because error is within the error range.