B O Ğ A Z İ Ç İ U N İ V E R S İ T Y
ELECTRICAL&ELECTRONIC ENGINEERING DEPARTMENT

EE 327-ELECTRICAL NETWORK LAB. REPORT

Number of The Experiment :***3***.....
Name of The Experiment :***Transients in Linear Circuits*** .....

Name of The Student: Çağdaş Kayra Akman
Name of The Partners: Onur Derin
Group No: Wednesday 1
Name of The Lab. Assistant:

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Delay

Do not fill in the grading table. It is for the instructor

Grading

General		/20
Data		/30
Discussion		/20
Answers		/30
Total		/100
Delay		
SCORE		/100

1. THE EQUIPMENT USED IN THE LAB

1. HAMEG HM-203-7 Dual Trace Oscilloscope with x10 probe
2. Escort EDM 168A Digital Multimeter
3. Black Star Jupiter 2000 Signal Generator
4. Resistors, capacitors and inductors of different values (see section 3 for these values)

2. THEORY AND METHOD

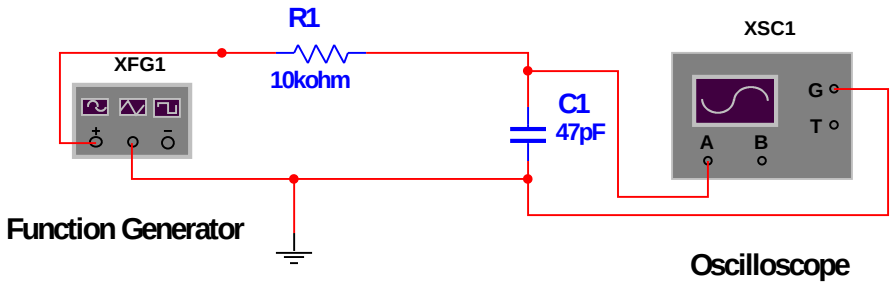
τThe objective of thisexperiment was to inspect the transien t responses of different circuits, RC, RL and RLC circuits, with varying component values and at different pulse input frequencies.
The energy storage elements such as capacitors and inductors store energy by building an electric and a magnetic field, respectively. The building-up of these fields, or their weakining, occurs due to the accumulated charge and induced voltage in the capacitor and across the inductor, respectively. These don't occur immediately but according to general formulas:

$V = A*(1-e^{-t/t})$ during the building up the fields, where V is the voltage across the capacitor in an RC circuit and across the resistor in an RL circuit, A is the amplitude of the input voltage, τ is the time constant (τ=R∗C for RC circuit, τ=L/R for RL circuit), and

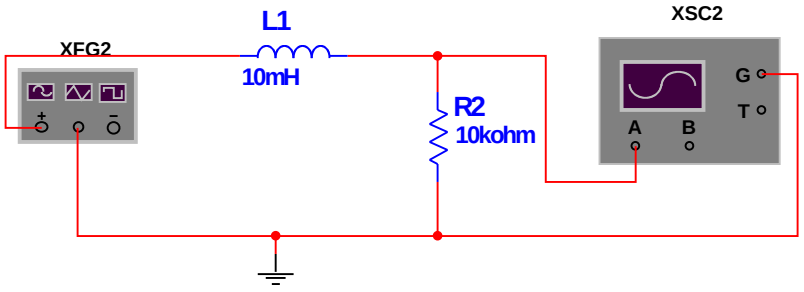
$V = A*e^{-t/t}$ during the weakening of the fields.

5τ is assumed to be the time period in which the exponential $e^{-t/\tau}$ reaches practically zero. f_{max} is calculated according to $f_{max}=1/10\tau$ since the capacitor voltage , resistor voltage in te RL circuit, has to reach the input voltage (1V) and then 0V within a period, ie. 5τ for charging up and 5τ for discharging has to pass.

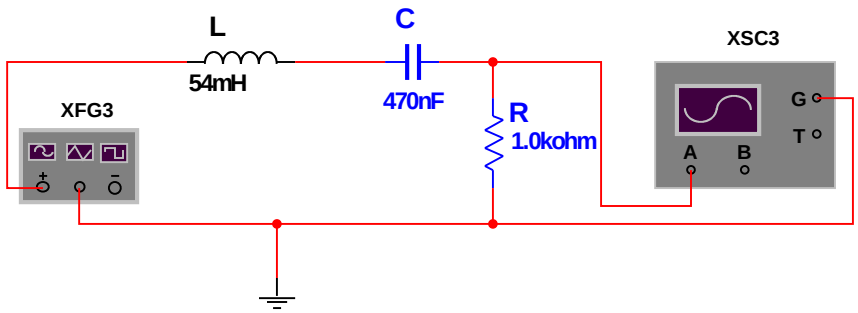
Experimental Setup 1:



Experimental Setup 2:



Experimental Setup 3:



The first two circuits shown above are implemented with the component values tabulated below.

3. DATA

Table 1

	R (Ω)	***C*** (F)	t (s)	***5*** t (s)	f_{max} (Hz)	f_{max} (Hz) (experimental)
1	1k	47p	47n	235n	2.13M	1.8M
2	1k	1n	1µ	5µ	100k	108k
3	1k	470n	470µ	2.35m	213	200
4	10k	47p	470n	2.35µ	213k	200k
5	10k	1n	10µ	50µ	10k	9.2k

	Charging Period		***Discharging Period***	
t	*Calculated*	*Measured*	*Calculated*	*Measured*
1	0.632	0.55	0.37	0.4
2	0.865	0.7	0.135	0.15
3	0.950	0.85	0.050	0.07
4	0.982	0.96	0.018	0.02
5	0.993	0.98	0.007	0.01

	R (Ω)	***L*** (H)	t (s)	***5*** t (s)	f_{max} (Hz)	f_{max} (Hz) (experimental)
1	1k	10m	10µ	50µ	10k	10k
2	4k7	10m	2.13µ	10.65µ	47k	50k
3	10k	10m	1µ	5µ	100k	105k

	Charging Period		***Discharging Period***	
t	*Calculated*	*Measured*	*Calculated*	*Measured*
1	0.632	0.6	0.37	0.4
2	0.865	0.85	0.135	0.15
3	0.950	0.93	0.050	0.05
4	0.982	0.95	0.018	0.02
5	0.993	0.98	0.007	0.01

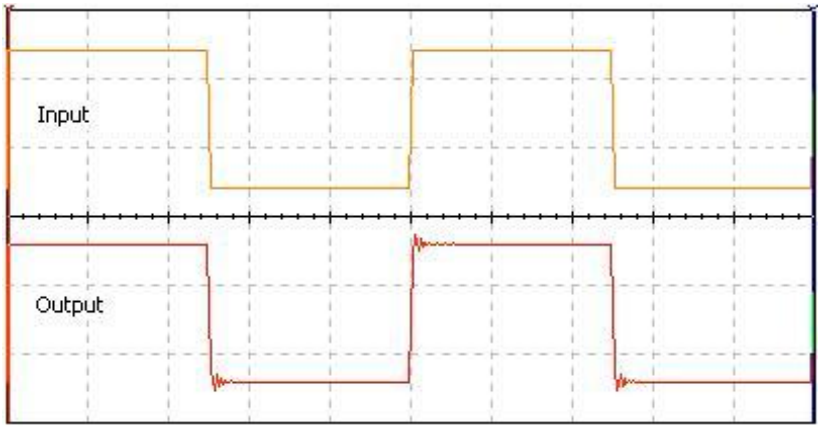
For all graphs, the amplitude of the input signal is 1V. The time axis is adjusted according to the frequency of the signal.

RC circuit:

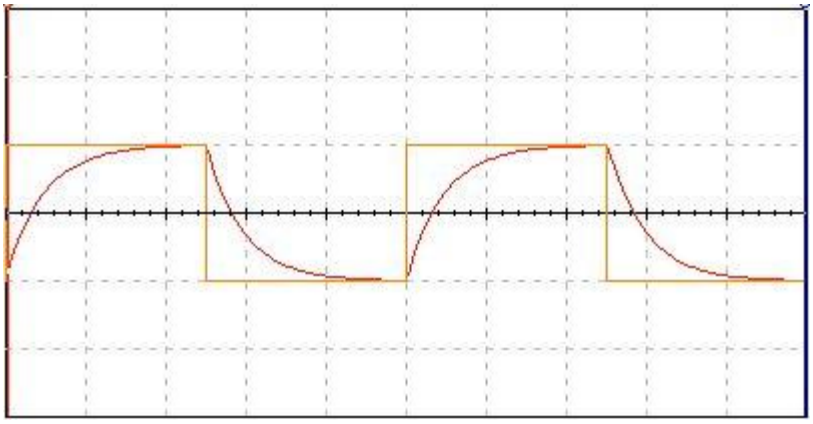
R=10kΩ, C=47pF

Voltages across the capacitor:

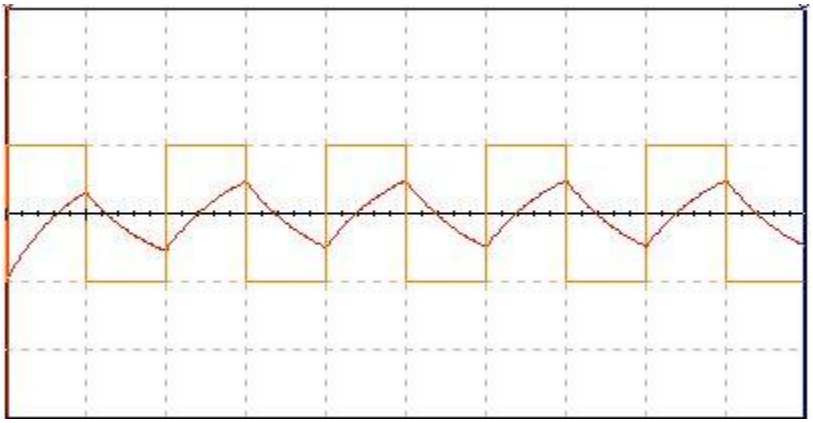
f=1kHz



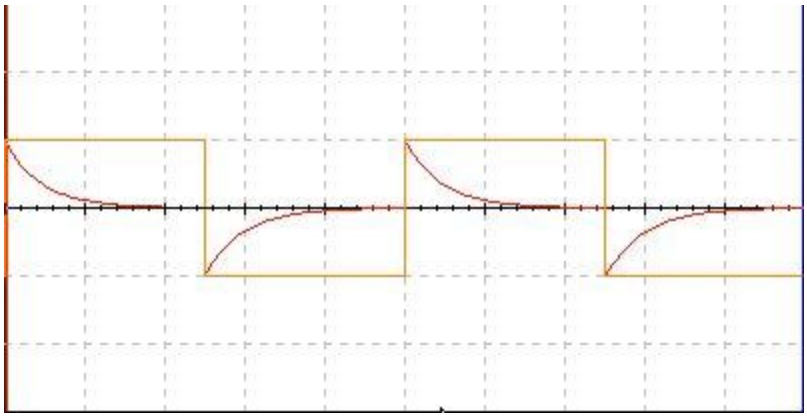
f=f_{max}=200kHz



f=1.06MHz=1/2τ



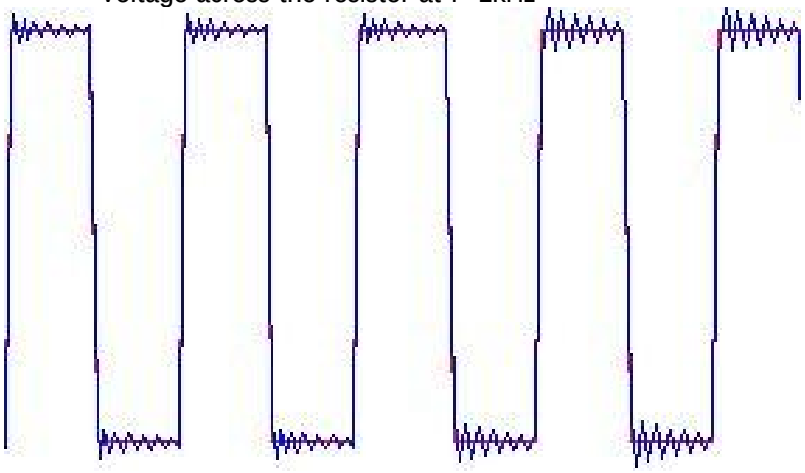
Voltage acrosss the resistor:
f=200kHz



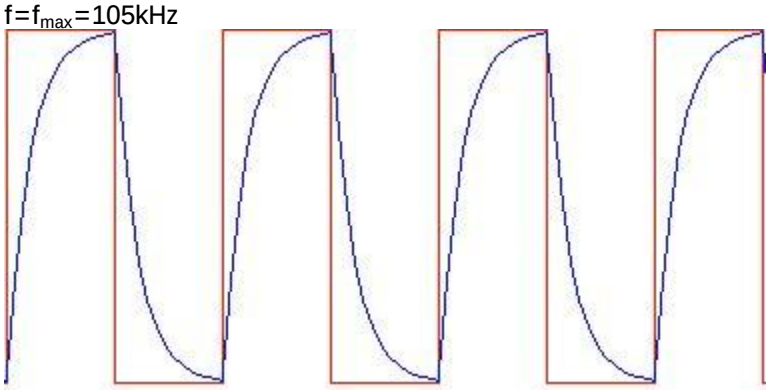
For other R and C vaues, the graphs look like the first one, and at their f_{max} values for input frequencies, the graphs look like the second graph.

R=10kΩ, L=10mH

Voltage across the resistor at f=1kHz

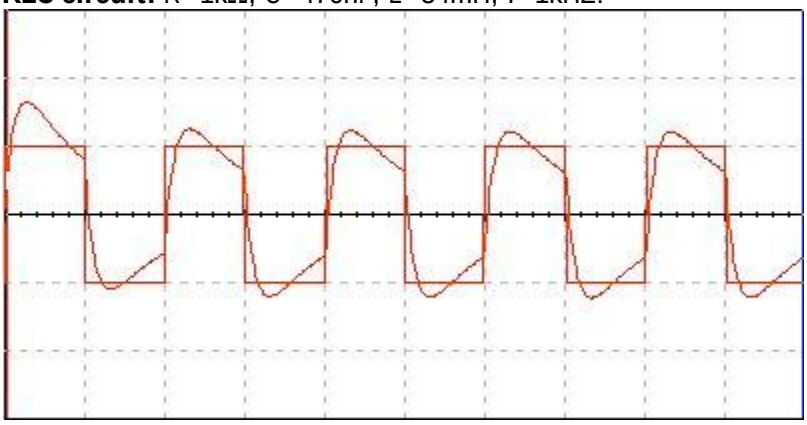


$f=f_{max}$=105kHz



For other R and L values, similar graphs are obtained.

RLC circuit: R=1kΩ, C=470nF, L=54mH, f=1kHZ:



For $\frac{R}{2}\frac{C}{L}=1$, R should be 230 kΩ, given that C=470nF and L=54mH. However, due to absence of adequate resistors, the circuit was experimented only with a 1kΩ resistor, ie. For $\frac{R}{2}\frac{C}{L}<1$.

4. ANALYSIS AND DISCUSSION

The theoretical experimental f_{max} values conformed to the experimental values very well. The minor differences are due to reading errors on the oscilloscope screen. The imperfactions of function generator affected the signal quality considerably, which in return affected the signal output observed with the oscilloscope. Especially at the edges of the square wave, unwanted glitches occurred.

The effect of 5τ was observed clearly. At the frequency 1/10τ, the capacitor voltage in teh RC circuit, or teh resistor voltage in teh RL circuit reached the input voltage at T/2, the half period as shown in the graphs.

5. ANSWERS TO THE QUESTIONS

No questions were given.