THE TECHNICAL UNIVERSITY OF KOŠICE
FACULTY OF ELECTRICAL ENEGINEERING AND INFORMATICS
DEPARTMENT OF ELECTRONICS AND MULTIMEDIA COMMUNICATIONS

Basic of electronics
Measurement no.3
Half- wave rectifier

Ac. Year: 2010/2011
Class / Group: 1.st / A1
Study : Applied Informatics

Tasks:

1.) Measure the static transfer characteristic of half- wave rectifier

2.) Measure the output waveform of half- wave rectifier in time domain with (and without) capacitor C, for different parameters of input periodic signal (frequency)

Circuit diagram:
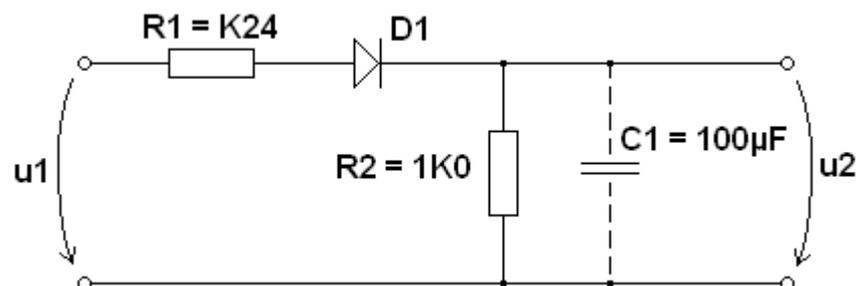
Theory:

General rectifier:

Rectifier is used to modify AC to DC. It is the most common connection using diodes. A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which is in only one direction, a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid state diodes, vacuum tube diodes, mercury arc valves, and other components.

Half-wave rectifier:

In half wave rectification, either the positive or negative half of the AC wave is passed, while the other half is blocked. Because only one half of the input waveform reaches the output, it is very inefficient if used for power transfer. Half-wave rectification can be achieved with a single diode in a one-phase supply, or with three diodes in a three-phase supply.
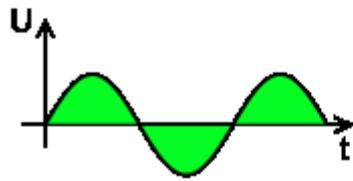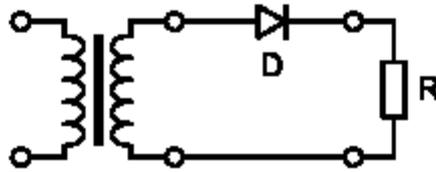
| Input voltage | Half-wave rectifier | Output voltage |
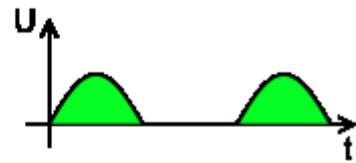
The output DC voltage of a half wave rectifier can be calculated with the following two ideal equations:

$$V_{dc} = \frac{V_{peak}}{\pi} \qquad V_{rms} = \frac{V_{peak}}{2}$$

Equasions
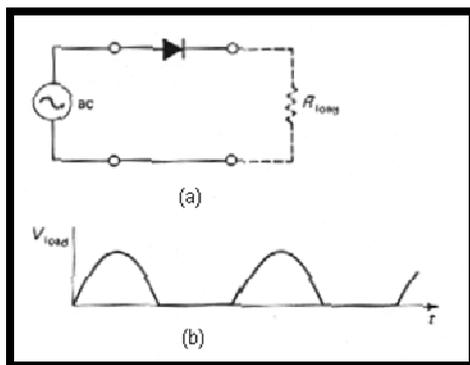
Half-wave rectifier with a diode (a). Input voltage sine wave (ac) with an amplitude much larger than ~ 0.6 V U_{DF} after passing through a silicon diode will have on the output of the form (b).

Only one half-cycle sinusoidal input voltage is used for rectify- from there the name Half-wave rectifier.

Full-wave rectifier:

A full-wave rectifier converts the whole of the input waveform to one of constant polarity (positive or negative) at its output. Full-wave rectification converts both polarities of the input waveform to DC and is more efficient. However, in a circuit with a non-center tapped transformer, four diodes are required instead of the one needed for half-wave rectification.. Four diodes arranged this way are called a diode bridge or bridge rectifier.
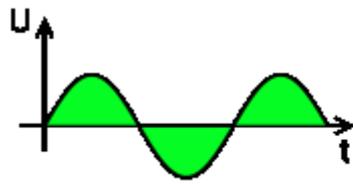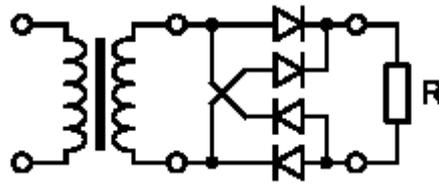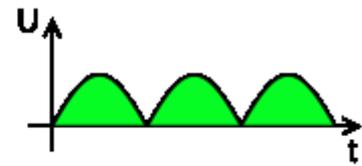
Input voltage · Full-wave rectifier · Output voltage

For single-phase AC, if the transformer is center-tapped, then two diodes back-to-back (i.e. anodes-to-anode or cathode-to-cathode) can form a full-wave rectifier. Twice as many windings are required on the transformer secondary to obtain the same output voltage compared to the bridge rectifier above.
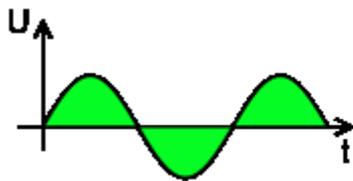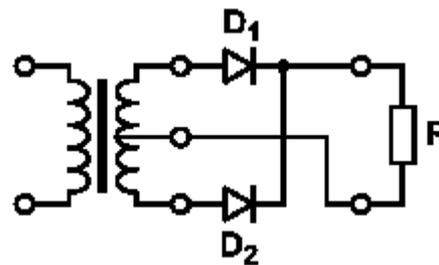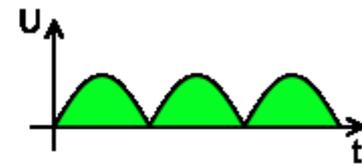
Input voltage · Full-wave rectifier · Output voltage

The average and root-mean-square output voltages of an ideal single phase full wave rectifier can be calculated as:

$$V_{rms} = \frac{V_p}{\sqrt{2}}$$

$$V_{dc} = V_{av} = \frac{2V_p}{\pi}$$

Equasions

Where:
Vdc,Vav - the average or DC output voltage,
Vp - the peak value of half wave,
Vrms - the root-mean-square value of output voltage.
π = ~ 3.14159
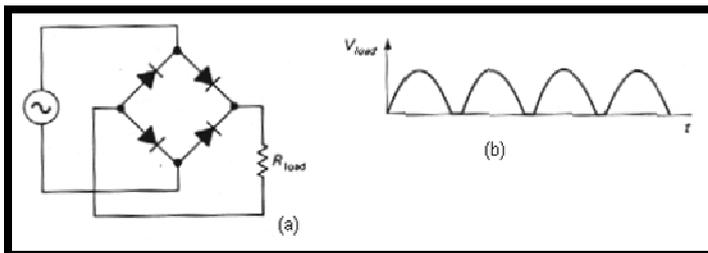
Full-way bridge rectifier with diode, using on the rectify both half-wave voltage sine wave. In the guidance of the bridged diodes are always two diodes conducting in the series.

Measurement:

1.) Measure the static transfer characteristic of half- wave rectifier.

In the **positive** direction:

Measurement no.	Input Voltage [V]	Output Voltage [V]
1	2	1,18
2	4	2,775
3	6	4,35
4	8	5,98
5	10	7,62
6	12	9,23
7	14	10,85
8	16	12,5
9	18	14,2
10	20	15,75

Table of measuring voltages

In the **negative** direction of voltage is always U_{out}= 0 V.

| Measurement no.	Input voltage [V]	Output voltage [V]
1	-10	0
2	-8	0
3	-6	0
4	-4	0
5	-2	0

Table of measuring voltages
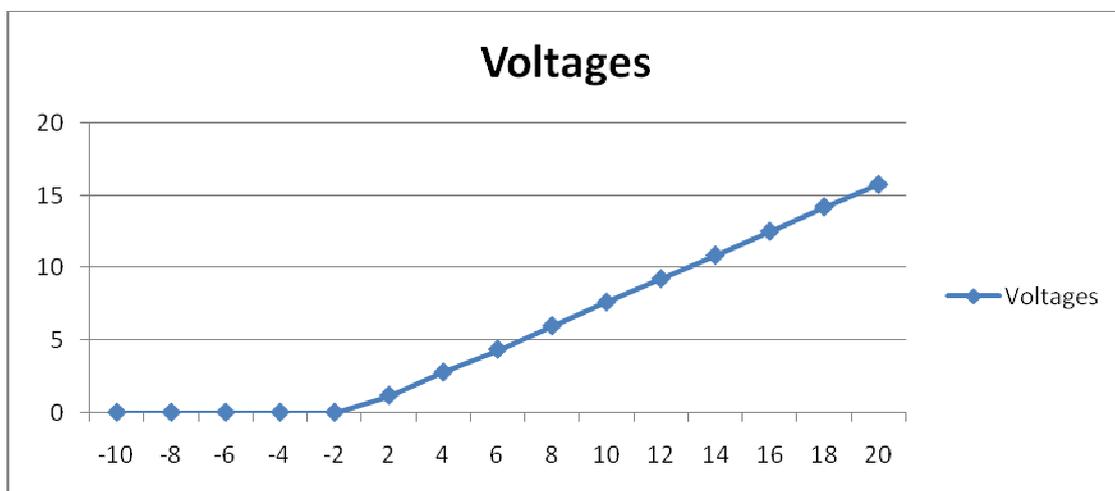
Graph of input/output voltages

2.) Measure the output waveform of half- wave rectifier in time domain with (and without) capacitor C, for different parameters of input periodic signal (frequency)

**Without** capacitors, the input and output waveforms weren´t different by changing frequencies.
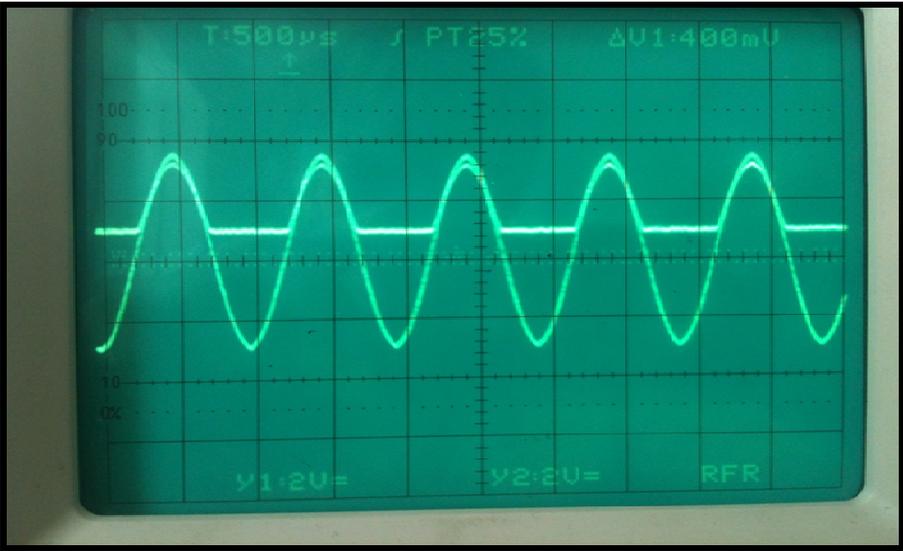
Picture no.1 – without capacitors

**With big and small capacitors** with different frequencies(*Note: 100K => f=100 Hz*):

f= x10
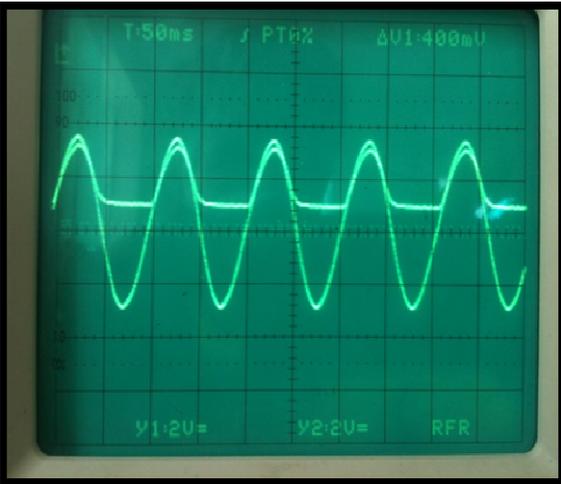
*Picture no.2 – small capacitor*
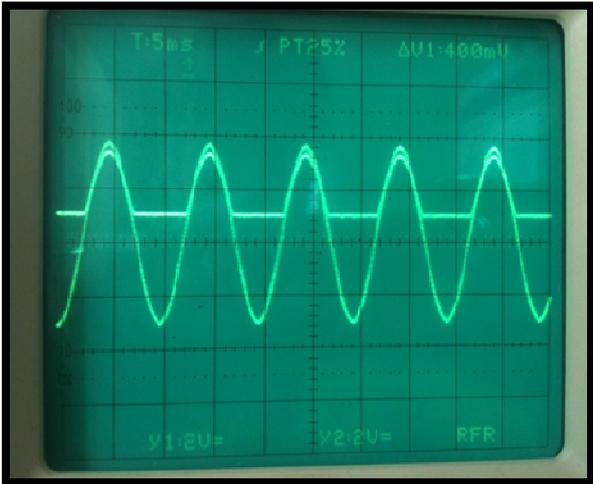
Picture no.3 – big capacitor

f= x100
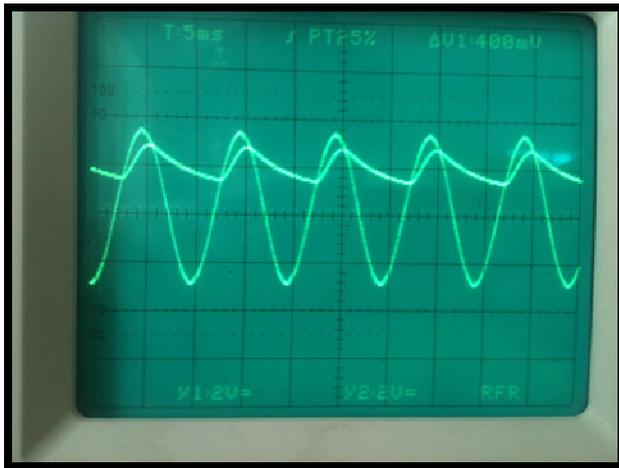
Picture no.4 – small capacitor
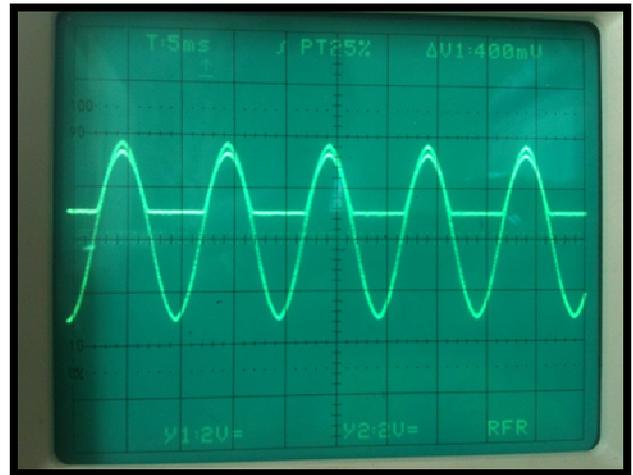
*Picture no.5 – big capacitor*

f= x10k
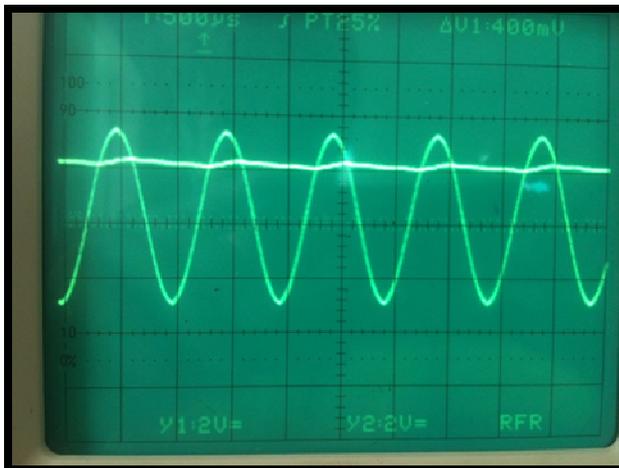
Picture no.6 – small capacitor
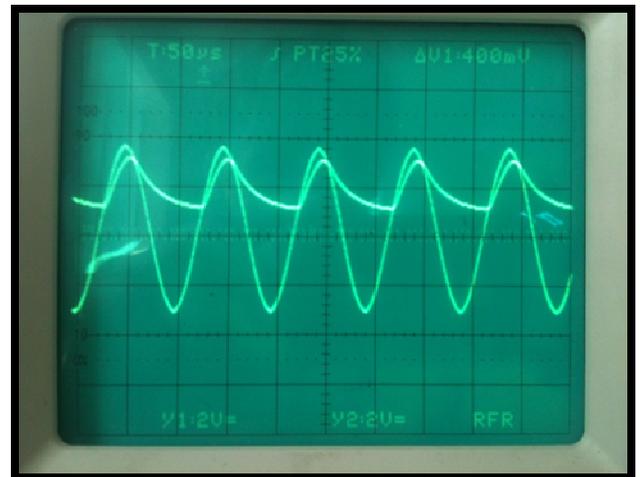
*Picture no.7 – big capacitor*

f= x100k
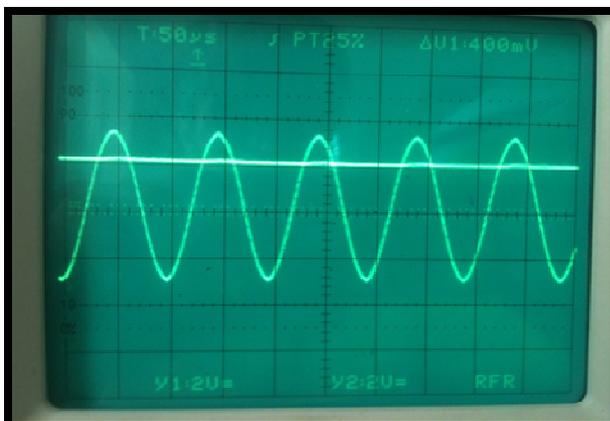

Picture no.8 – small capacitor
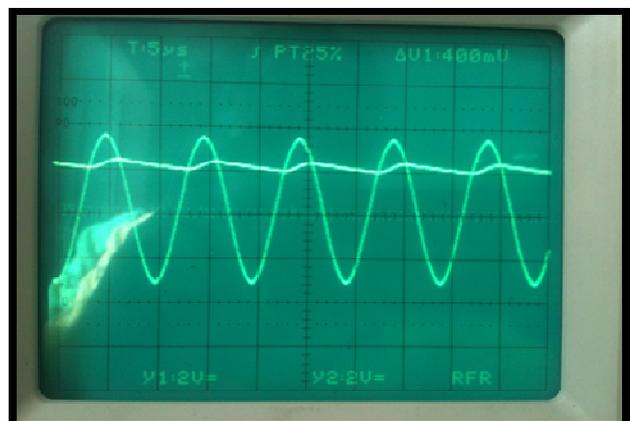
Picture no.9 – big capacitor

SPICE Simulations

We have made a SPICE simulation according to the measurements and values given as output values. We changed the frequency and capacity, and we can see how the output changed on the pictures, taken from spice simulation.
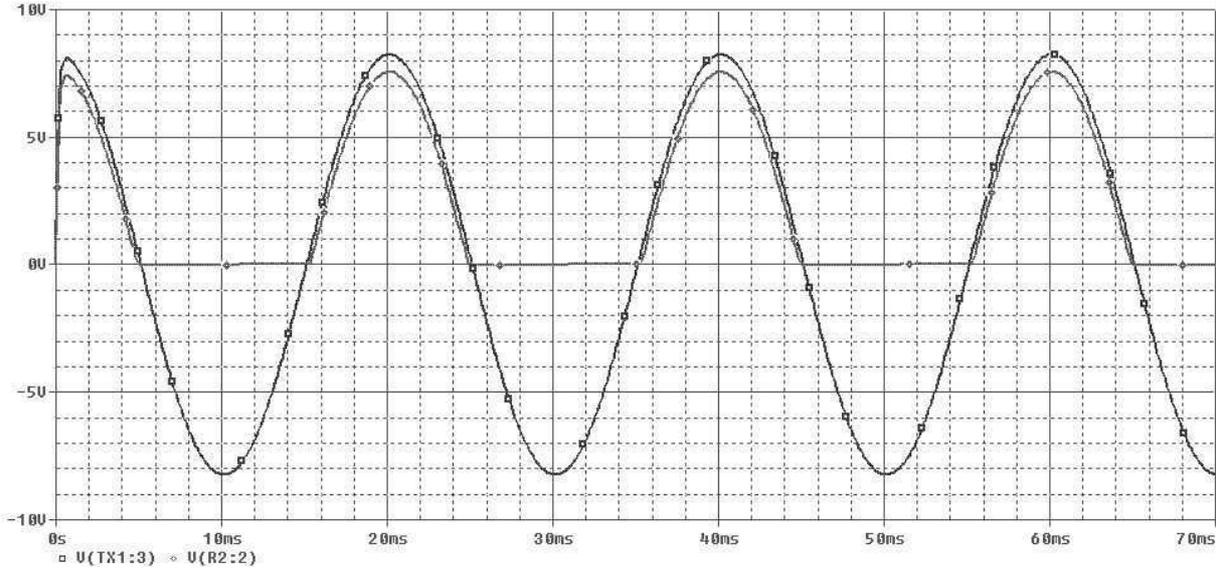
Spice simulation no.1 – without capacitor, frequency did not changed the output lines
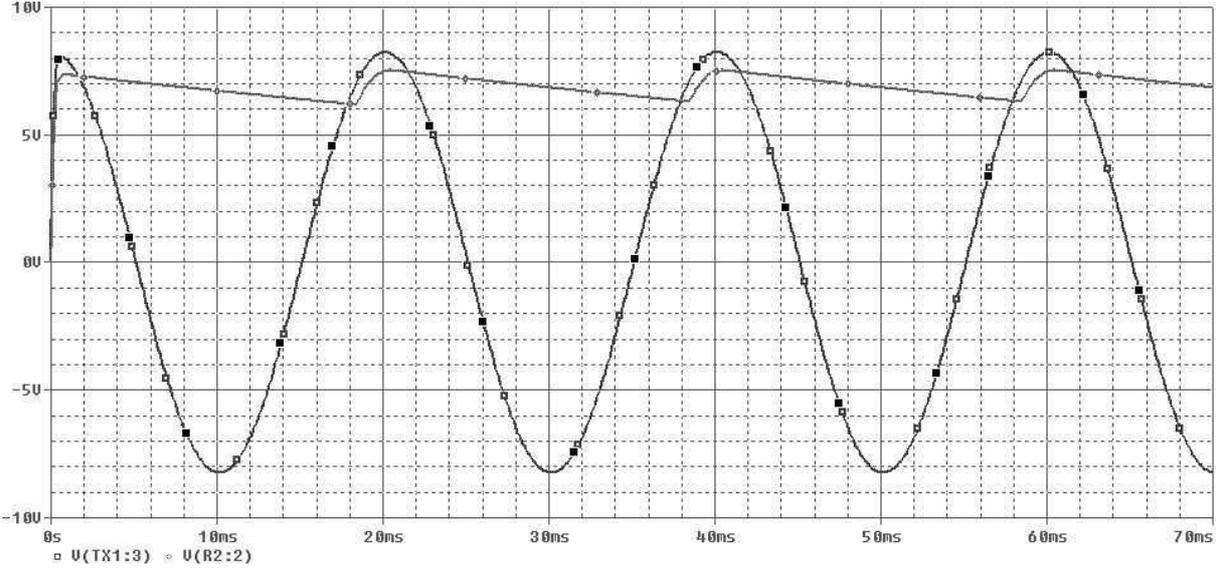
Spice simulation no.2 – we used small capacitor, but higher frequency
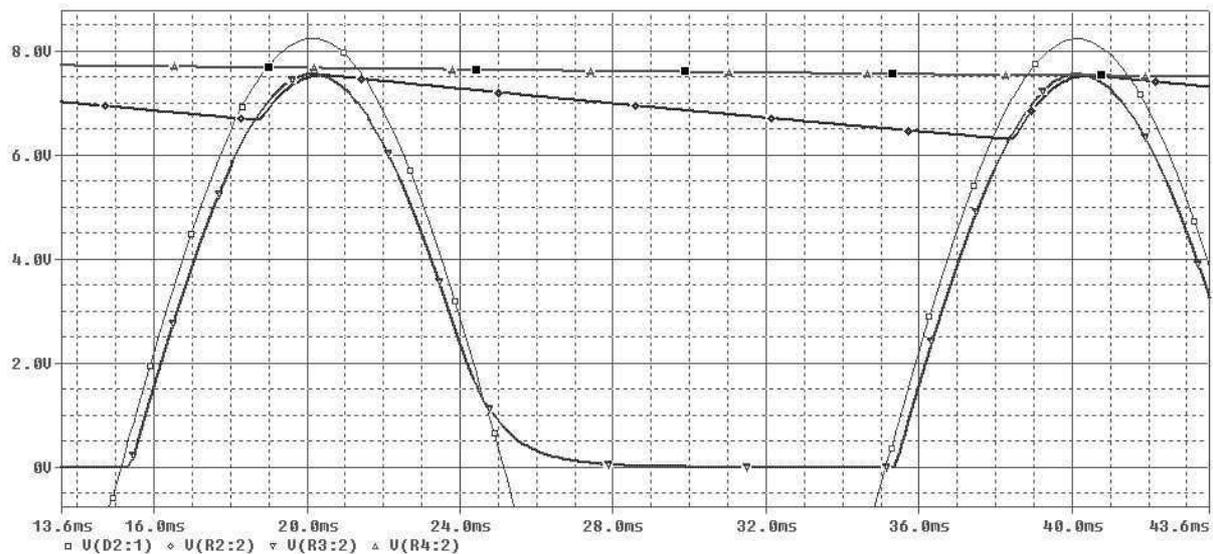
Spice simulation no.3 – higher frequency changed the output line

Conclusion:

At the beginning of measurement, we have prepared voltmeter, oscilloscope, cables, multimeter and half-wave rectifier with 2 different capacitors. Then we´ve connected the circuit according to the figure on the picture. After that, we´ve connected the circuit to the oscilloscope and multimeter. We changed the frequency and by this changing, we have also changed amplitude and we were looking for a point where the output amplitude change almost into a straight line. That we applied in all three cases, without capacitor, with bigger and with smaller capacitor. Then we´ve connected circuit without capacitors into the multimeter and voltmeter and we we´re changing input voltage and measuring the output voltage on the voltmeter.

We were trying to measure the most accurate, but for short time and our not very good skills, we weren´t able to measure a more precisely results.

Resources:

http://en.wikipedia.org/wiki/Rectifier#Half-wave_rectification
http://www.dnp.fmph.uniba.sk/~kollar/jewww/dioda.htm
http://alzat.szm.com/zdroje/jednocestny/jcusmsr.htmh
http://alzat.szm.com/zdroje/dvojcestny/dcusmsr.html