DEPARTMENT OF ELECTRONICS AGH UST

LABORATORY
OF
ELECTRONIC ELEMENTS

APPLICATIONS OF DIODES

REV. 1.1

1. THE GOAL OF THE EXERCISE

- Practical verification of diode circuits working as:
  - voltage limiting circuit (voltage clipper, voltage shifter),
  - signal forming circuit,
  - logic circuit,
  - rectifier circuit.

2. THE UTILIZED MODELS AND ELEMENTS

During the exercise following components will be used:

- NI ELVIS Prototyping Board (ELVIS) connected with PC,
- Virtual measurement devices: Virtual Instruments (VI):
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- Digital Multimeter (DMM),
- Function Generator (FGEN),
- Variable Power Supplies (VPS)
- Oscilloscope (SCOPE)

- Tektronix digital oscilloscope
- Agilent multimeter
- Set of electronics elements listed in Table 1.

Table 1. Values of electronics elements required to perform the exercise

Resistors	10x1,2kΩ, 2x18kΩ, 2x43kΩ, 2x91kΩ,
Capacitors	1x100nF, 2x2,2µF, 2x22µF, 2x100µF, 2x1000µF
Diodes	rectifier diodes x 10, Zener diodes: 2x3.3V, 2x4.3V, 2x4.7V, 2x6.2V

3. PREPARING THE DRAFT

3.1. For the circuit schemes shown below (Fig. 3.1), draw the characteristics $U_{OUT}=f(U_{IN})$ for the input voltage range (-10V ; +10V); assuming an ideal diode I=f(U), where voltage drop in a forward bias mode equals U_D=0,7V, dynamic resistance r_d=0Ω. Propose a method of characteristics verification with the use of NI ELVIS Prototyping Board (ELVIS).

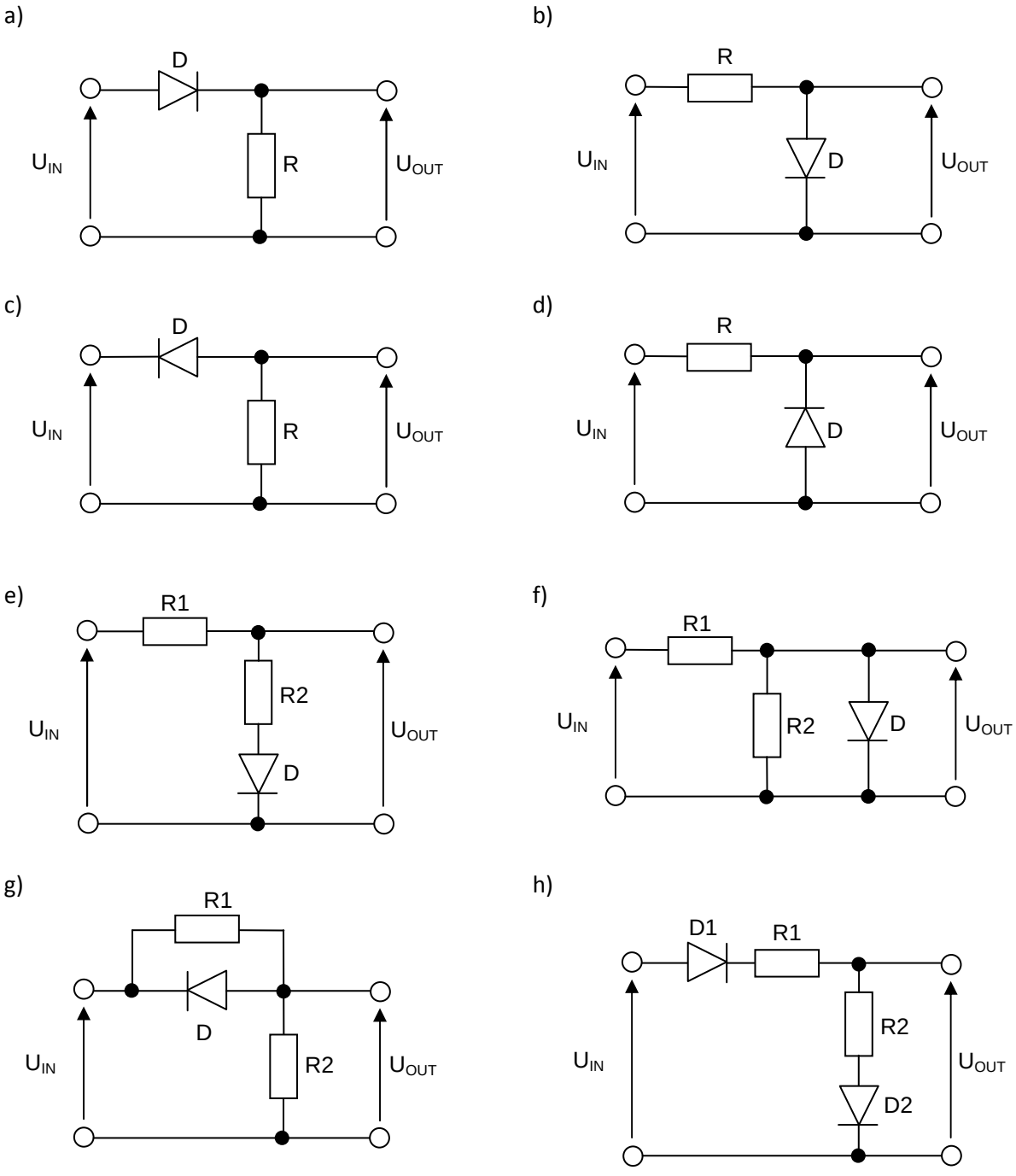

Fig. 3.1. Two-port networks schemes including semiconductor diodes.

3.2. Present the circuit scheme, utilizing semiconductor diodes and 1,2kΩ resistors, that could transform triangle wave having frequency 100 Hz and amplitude value 10V in the sine wave (see Fig. 3.2). Assume, that the linearization ratios are equal: m_1=1,0; m_2=0,5; m_3=0,33; m_4=0,25.

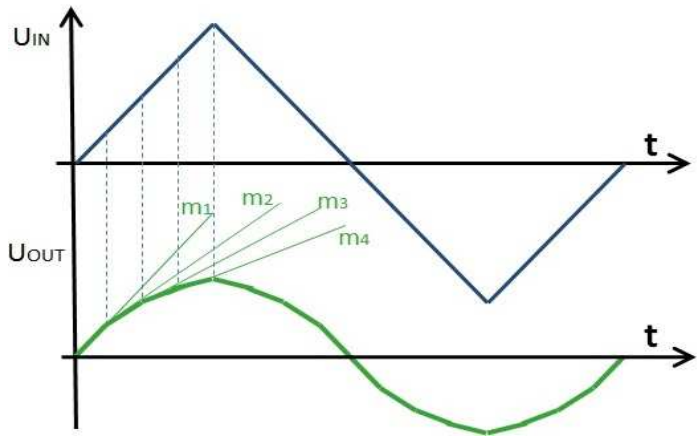

Fig. 3.2. Voltage waveform forming – transformation of triangle wave into sine wave.

3.3. Assuming that signals U_A and U_B can take only 0V or +5V (Fig. 3.3), determine output voltage level for all four possible combination of input voltage levels. Which logical function does the circuit presented below realize?

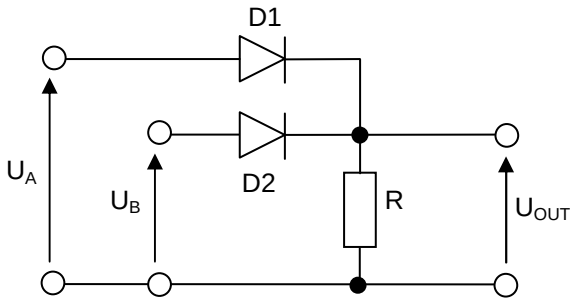

Fig. 3.3. Diodes in logic circuit.

3.4. Prepare schematics of: a). simple half-wave rectifier, b). full-wave rectifier with Graetz bridge. Assuming that the input voltage will be sine wave having amplitude 10 V and frequency 50 Hz, connect to the output of the rectifiers the smallest available R_L resistor, which does not cause the increase of output current above 10 mA. In the next step, choose from the available capacitors C_L one, having the smallest capacitance, which fulfills the condition: $(1/R_LC_L) \leq$ output signal frequency.

3.5. Design the voltage clipper circuits for the set of voltages from Table 2. Take into account, that output current cannot be higher than 10 mA when input sine wave voltages having amplitude 10 V are considered.

Table 2. Data sets for voltage clippers

Set	A		B		C		D		E	
	U_{min} [V]	U_{max} [V]	U_{min} [V]	U_{max} [V]	U_{min} [V]	U_{max} [V]	U_{min} [V]	U_{max} [V]	U_{min} [V]	U_{max} [V]
	-4	+4	-7,9	+5	-4	+7,9	-4,7	+0,7	-0,7	+6,2

4. THE COURSE OF THE EXERCISE

4.1. Verify experimentally two circuits from 3.1 (chosen by the teacher) and compare obtained measured $U_{OUT}=f(U_{IN})$ characteristics with the prepared ones. Choose resistors in such a manner that current flowing through the diodes will be lower than 25 mA. The characteristics $U_{OUT}=f(U_{IN})$ can be obtained with the use of:

a). „point by point" method (VPS, DMM, Agilent multimeter),

b). registering the measurements on two channels in SCOPE with the use of LOG function, providing,

c). utilization of XY function of Tektronix oscilloscope, providing a triangle wave having amplitude equal 10 V (FGEN) at the input of the circuit,

4.2. Verify experimentally, how the circuit from 3.2 works. What amplitude value has the signal at the output of the circuit and why?

4.3. Verify experimentally, how the circuit from 3.3 works. Choose resistors in such a manner that current flowing through the diodes will be lower than 25 mA.

4.4. Verify experimentally, how the circuit from 3.4 works. Investigate how the circuit works with and without C_L capacitor and also with C_L having capacitance ten times greater than the one calculated in 3.4. How does the output voltage change, when the frequency is changed? What does the amplitude of output voltage ripple depend on? Try to formulate the simplified analytical relationship for the amplitude of the voltage ripple.

4.5. Verify experimentally two voltage clipper circuits chosen by the teacher from 3.5. Present following functions on the graph: $U_{OUT}=f(t)$ and $U_{OUT}=f(U_{IN})$ **.**

5. LITERATURE

[1] Lecture (P. Dziurdzia)

[2] Behzad Razavi „Fundamentals of Microelectronics"

Rev 1.1 – changes in Table 1: resistors (1,2kΩ instead of 1kΩ), capacitors (2,2µF instead of 1,0µF; 22µF instead of 10µF), Zener diodes (4,7V instead of 4,3V; 6,2V instead of 6,8V). Changes in voltage values in Table 2.