CIRCUITS AND SYSTEMS LABORATORY

EXERCISE 8

BASIC ACTIVE TWO-PORT NETWORKS AND THEIR APPLICATIONS
PART II

1. DEVICES AND PANELS USED IN EXERCISE

The following devices are to be used in this exercise:
- stabilized DC voltage supply panel,
- integrator and differentiator panel, signed “Układ różniczkujący / Układ całkujący”,
- operational amplifiers panel, signed “Układy aktywne”,
- generator HP 33120A,
- oscilloscope HP 54603B,
- decade resistor,
- 0.1 μF capacitor,
- two 10 kΩ resistors.

2. PROGRAM OF EXPERIMENTS

2.1. THE DIFFERENTIATING CIRCUIT

Determination of the frequency characteristic of the circuit $U_o = \varphi(f)$ at sinusoidal excitation with constant input voltage value U_i.

The configuration of the metering circuit is shown in figure 1. The function generator should be set up to obtain a sinusoidal shaped output voltage of around 1 V.

The output voltage value will be measured for variable frequency of a range of 10 ÷ 2000 Hz. The results are to be written in table 1 and the $U_o = \varphi(f)$ characteristic should be drawn on the basis of it’s contents.

Table 1

Results table for the differentiator frequency characteristic

f [Hz]														
U_o [V]														
U_i =														

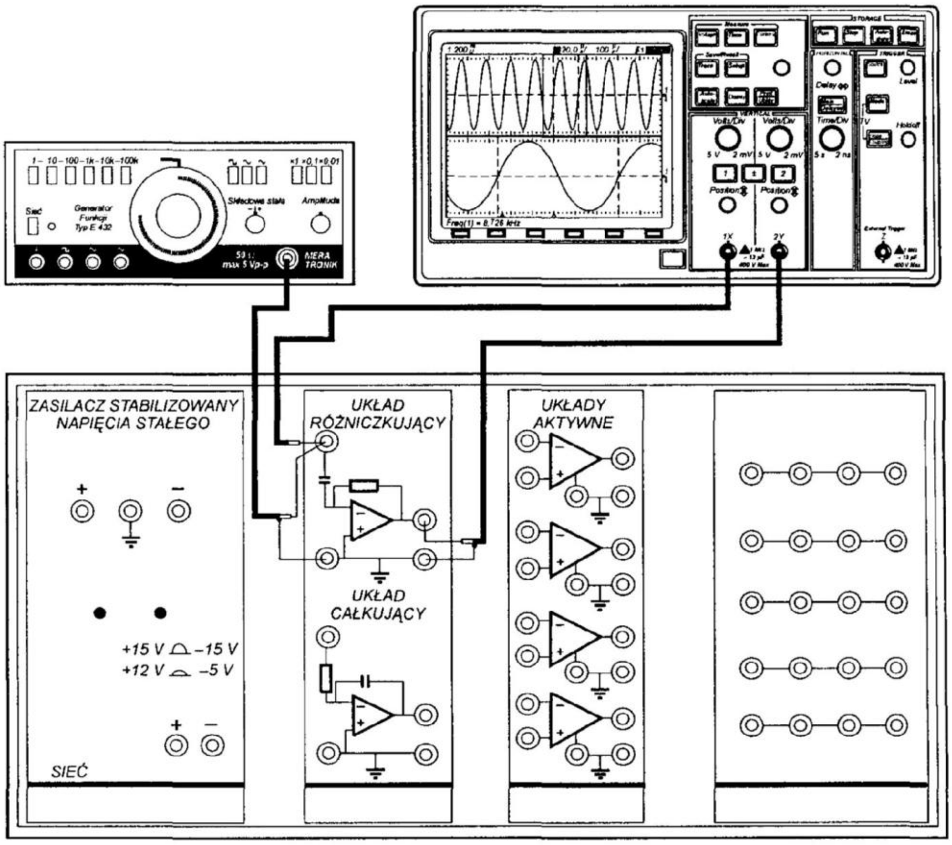

Fig. 1 Configuration diagram for determination of phase and amplitude characteristics of the differentiating circuit

Determination of the transfer characteristic of the circuit $U_o = \varphi(U_i)$ at sinusoidal excitation with constant frequency value *f*.

The metering circuit remains the same as for the previous measurements (fig. 1). The function generator should be set up to obtain a sinusoidal shaped output voltage of the frequency of 500 Hz.

The output voltage value will be measured in dependence of the input voltage value, which should vary in a range of 0.35 ÷ 2.5 V. The results are to be written in table 2 and the $U_o = \varphi(U_i)$ characteristic should be drawn on the basis of it's contents.

Table 2

Results table for the differentiator transfer characteristic

U_i [V]														
U_o [V]														
f =														

After making the above measurements, one will make observations of the differentiating circuit response to the rectangular and triangular excitation, using the same circuit configuration (fig. 1). The task should be accomplished by setting up the generator to obtain the rectangular output voltage and redraw (or print if possible) the excitation and circuit response time functions graphs from the oscilloscope. Next, one needs to set up the triangular output voltage of the generator and again, redraw or print the two time function graphs from the oscilloscope.

2.2. THE INTEGRATING CIRCUIT

Determination of the frequency characteristic of the circuit $U_o = f(f)$ at sinusoidal excitation with constant input voltage value U_i.

The configuration of the metering circuit is shown in figure 2. The function generator should be set up to obtain a sinusoidal shaped output voltage of around 1 V.

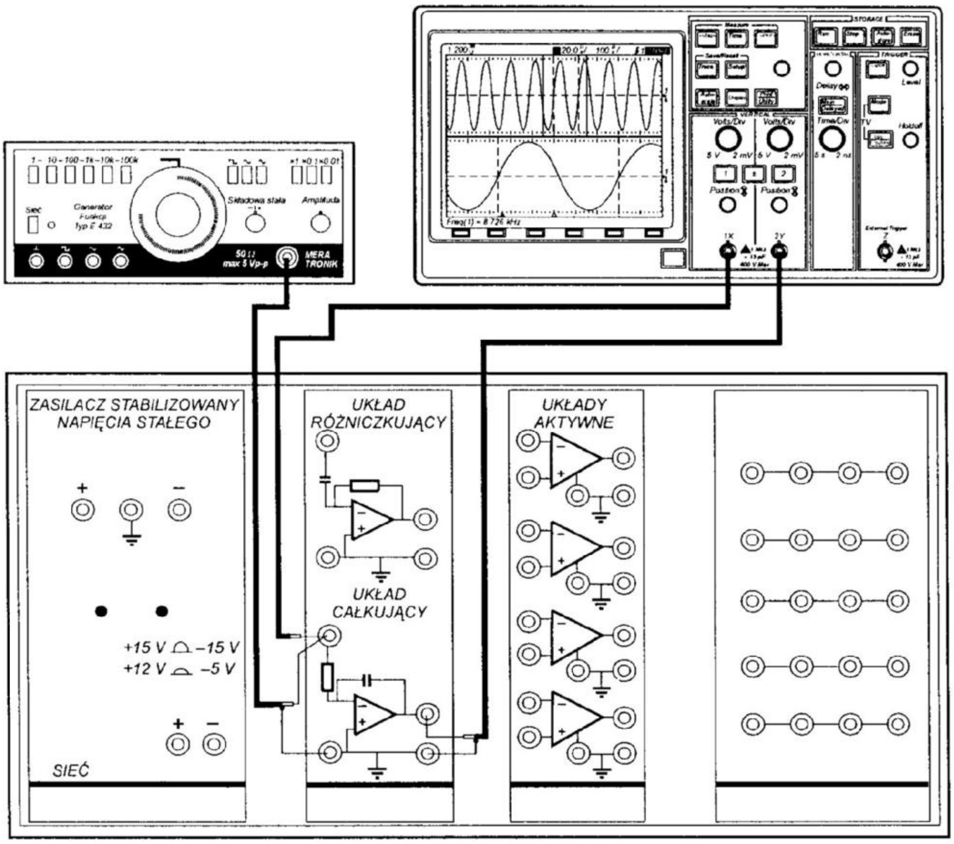

Fig. 2 Configuration diagram for determination of phase and amplitude characteristics of the integrating circuit

The output voltage value will be measured for variable frequency of a range of 10 ÷ 1500 Hz. The results are to be written in table 3 and the $U_o = f(f)$ characteristic should be drawn on the basis of it's contents.

Table 3

Results table for the integrator frequency characteristic

f [Hz]														
U_o [V]														
U_i =														

Determination of the transfer characteristic of the circuit $U_o = f(U_i)$ at sinusoidal excitation with constant frequency value f.

The metering circuit remains the same as for the previous measurements (fig. 2). The function generator should be set up to obtain a sinusoidal shaped output voltage of the frequency of 500 Hz.

The output voltage value will be measured in dependence of the input voltage value, which should vary in a range of 0.35 ÷ 2.5 V. The results are to be written in table 4 and the $U_o = f(U_i)$ characteristic should be drawn on the basis of it's contents.

Table 4

Results table for the integrator transfer characteristic

U_i [V]														
U_o [V]														
f =														

As well as for the differentiating circuit, one will make observations of the integrating circuit response to the rectangular and triangular excitation, using the same circuit configuration (fig. 2). The task should be accomplished by setting up the generator to obtain the rectangular output voltage and redraw (or print if possible) the excitation and circuit response time functions graphs from the oscilloscope. Next, one needs to set up the triangular output voltage of the generator and again, redraw or print the two time function graphs from the oscilloscope.

2.3. THE PHASE SHIFTER

The phase shifter is a two-port network that allows the output voltage phase change comparing to the input voltage. The example schematic diagram of practical implementation of the network is shown in figure 3.

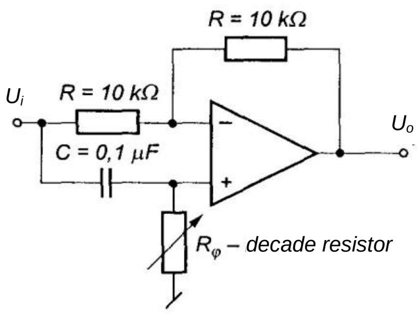

Fig. 3 Schematic diagram of the phase shifter

The transmittance of such circuit is given by the following formula:

$$T_v(s) = \frac{sC - \frac{1}{R_\varphi}}{sC + \frac{1}{R_\varphi}}$$

The frequency characteristics (of amplitude and phase) of the circuit equal as follows:

– $|T_v(j\omega)| = 1$,

– $\arg T_v(j\omega) = 180° - 2 \cdot \arctan(\omega RC)$,

hence, the phase shift is regulated by either the R_φ or C value.

Determination of the frequency characteristic of the circuit $U_o = f(f)$ at sinusoidal excitation with constant input voltage U_i and R_φ resistance values.

One will start the examination of the phase shifter by configuring the metering circuit on the basis of figure 3. The function generator should be set up to obtain a sinusoidal shaped output voltage of around 400 mV.

The output voltage value will be measured for variable frequency of a range of 50 ÷ 5 kHz. The results are to be written in table 5 and the $U_o = f(f)$ characteristic should be drawn on the basis of it's contents.

Table 5

Results table for the phase shifter frequency characteristic

f [Hz]														
U_o [mV]														
U_i = , R_φ =														

Determination of the transfer characteristic of the circuit $U_o = f(U_i)$ at sinusoidal excitation with constant frequency f and R_φ resistance values.

The metering circuit remains the same as for the previous measurements (fig. 3). The function generator should be set up to obtain a sinusoidal shaped output voltage of the frequency of 1 kHz.

The output voltage value will be measured in dependence of the input voltage value, which should vary in a range of 0.35 ÷ 2.5 V. The results are to be written in table 6 and the $U_o = f(U_i)$ characteristic should be drawn on the basis of it's contents.

Table 6

Results table for the phase shifter transfer characteristic

U_i [V]														
U_o [V]														
f = , R_φ =														

Determination of the phase shift characteristic $\varphi = f(R_\varphi)$ at sinusoidal excitation with constant frequency f and input voltage U_i values.

The metering circuit remains the same as for the previous measurements (fig. 3). The function generator should be set up to obtain a sinusoidal shaped output of the fixed frequency and voltage values (e.g. f = 1 kHz, U_i = 1 V).

The phase shift angle φ will be measured in dependence of the R_φ resistance value, which should vary in a range of 0.2 ÷ 100 kΩ. The measurement of the shift angle φ should be made on the basis of the time difference Δt between the input and output voltage time functions graphs read with use of the oscilloscope cursors. The results are to be written in table 7 and the $\varphi = f(R_\varphi)$ characteristic should be drawn on the basis of it's contents.

Table 7

Results table for the phase shift angle characteristic

R_φ [kΩ]														
Δt [ms]														
φ [°]														
f = , U_i =														

3. RESULTS PROCESSING

After running the experiments, one should:

1. Draw the characteristics for particular circuits as demanded in exercise description.
2. Draw the time function graphs of the integrator and differentiator response to rectangular and triangular excitation as demanded in exercise description. Although if the time functions graphs were printed out, one should describe the printouts properly, marking the quantity axes and significant points and/or values.