EXPERIMENT 8
VOLTAGE-CONTROLLED OSCILLATOR

1. PURPOSE:
An integrator and a Schmitt Trigger circuitry will be put together to build a device whose output frequency can be controlled with an input voltage; hence its name “voltage-controlled oscillator.”

2. VOLTAGE-CONTROLLED OSCILLATOR
Figure 1 shows the different components of the device (obtained from reference 1), broken down into three main sections to facilitate its analysis.

![Diagram of voltage-controlled oscillator](diagram.png)

**Fig.1** Device to control the frequency of the output voltage. An unusual feature of the circuit is its operation using a single positive supply.¹
Fig. 2 Optional switches.

**TASKS:**

*i)* Analyze the Schmitt Trigger first. Make a diagram of the expected hysteresis curve behavior.

![Graph: V_out vs V_monitor](attachment:image.png)

*ii)* Analyze how the Schmitt Trigger control the switch section (the transistor).

*iii)* For the two cases (switch off and switch on) analyze the behavior of the integrator.
iii-1) Obtain an expression for $V_{\text{monitor}}$ as a function of time when the switch is OFF. Hint: It will help to sketch the flow of current (magnitude and direction) across the resistors and capacitor.

iii-2) Obtain an expression for $V_{\text{monitor}}$ as a function of time when the switch is ON.

iii-3) Obtain an expression that can allow evaluating how long does it take for the Schmidt trigger to change its output back and forth.

iv) Based on the above analysis, estimate the time-period at which the output voltage changes states.

Highlight the variables that influence the value of the period. According to this analysis, adjust the proper values of the different component in order to have a clear measurable variation of the period as the DC input voltage varies.

Hence, measure how much the frequency of the output voltage changes as a function of $V_{\text{in}}$ (for various values of $C$.) In addition to $C$, feel free to change the values of other components.

v) Plot frequency of $V_{\text{out}}$ vs $V_{\text{in}}$.

Describe the agreement between the expected theoretical values and the experimental results.

vi) Use the oscilloscope to monitor simultaneously both the output voltage from the integrator ($V_{\text{monitor}}$) and $V_{\text{out}}$.