Name ______________________
Date ______________________
Instructor ______________________

EXPERIMENT 31

Oscillator Circuits

OBJECTIVE

To measure voltage waveforms in various oscillator circuits.

EQUIPMENT REQUIRED

Instruments

Oscilloscope
DMM
Function generator
DC power supply

Components

Resistors

(3) 10-kΩ
(1) 51-kΩ
(1) 100-kΩ
(1) 220-kΩ
(1) 500-kΩ pot

Capacitors

(3) 0.001-μF
(3) 0.01-μF
(1) 15-μF

ICs

(1) 7414 Schmitt Trigger IC
(1) 741 (or equivalent) op-amp
(1) 555 Timer IC

EQUIPMENT ISSUED

Item	*Laboratory serial no.*
DC power supply	
Function generator	
Oscilloscope	
DMM	

RÉSUMÉ OF THEORY

Oscillator circuits can be built using op-amps with feedback to phase-shift the output signal by 180°. Phase-shift: In a phase-shift oscillator, as shown in Fig. 31.1, three sections of resistor-capacitor are used. The resulting oscillator frequency can be calculated using

$$f = \frac{1}{2\pi\sqrt{6}RC} \text{ Hz} \tag{31.1}$$

For the op-amp to cause the circuit to oscillate requires that the op-amp gain be of magnitude 29.

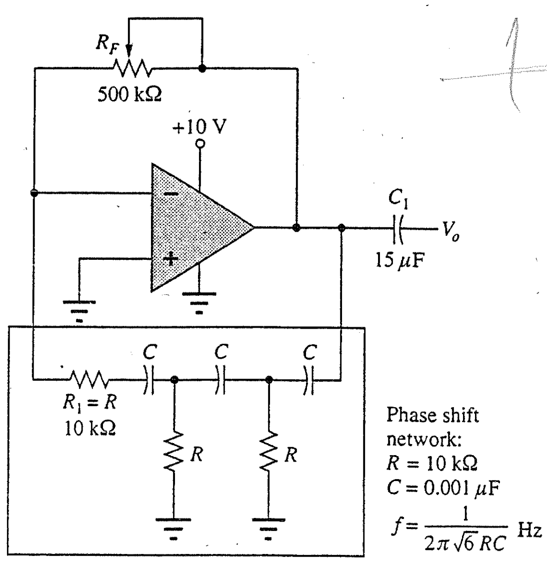

Figure 31-1

Wien-Bridge

A bridge network can be used to provide the 180° phase shift as shown in Fig. 31.2. The circuit's resulting frequency can be calculated from

$$f = \frac{1}{2\pi\sqrt{R_1C_1R_2C_2}} \tag{31.2}$$

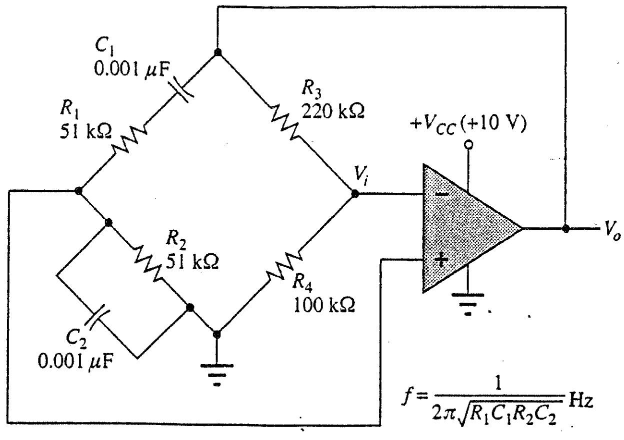

Figure 31-2

If $R_1 = R_2 = R$, and $C_1 = C_1 = C$, then

$$f = \frac{1}{2\pi RC} \text{ Hz} \tag{31.3}$$

Square-Wave Oscillator

A 555 Timer IC is a versatile linear digital IC which can be wired for operation as an oscillator, as shown in Fig. 31.3. The output resulting from this circuit is a pulse clock waveform of frequency

$$f = \frac{1.44}{(R_A + 2R_B)C} \text{ Hz} \tag{31.4}$$

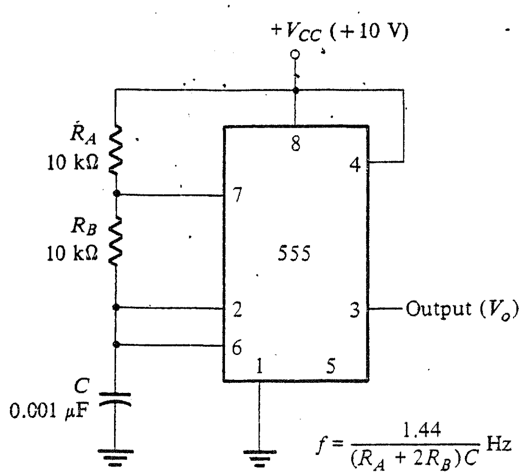

Figure 31-3

Schmitt-Trigger Oscillator

A single Schmitt-trigger IC, resistor, and capacitor can be used to build a pulse-type oscillator circuit, as shown in Fig. 31.4. The oscillator frequency is generally calculated using

$$f = \frac{k}{RC} \text{ Hz} \tag{31.5}$$

where k is typically 0.3 to 0.7, depending on the internal triggering levels of the Schmitt-trigger IC.

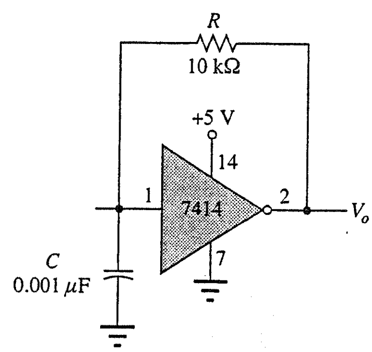

Figure 31-4

PROCEDURE

Part 1. Phase-Shift Oscillator

a. Construct the circuit of Fig. 31.1 with a R_F = 500 kΩ potentiometer, R_1 = 22 kΩ, R = 100 kΩ and C = 0.001 μF. (Measure and record the resistor values in Fig. 31.1.)

b. Use the oscilloscope to record the output waveform of the oscillator circuit in Fig. 31.5. Adjust R_F for maximum undistorted output waveform, V_o. Record value of R_F for this undistorted condition.

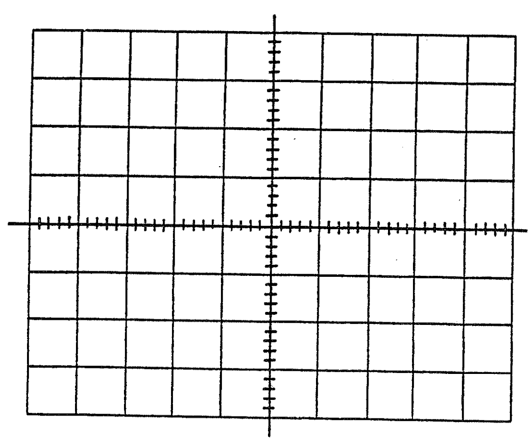

Figure 31-5

R_F (measured) = ____________

c. Measure and record the time for one cycle of the waveform.

T (Period) (measured) = ____________

d. Determine the frequency of the waveform.

f (Frequency) = $1/T$ = ____________

e. Replace the capacitors with C = 0.01 μF and repeat steps 1(**c**) through 1(**d**).

T (Period) (measured) = ____________

f (Frequency) = $1/T$ = ____________

f. Calculate the theoretical frequency using Eq. 31.1 for both capacitor values.

$f(C$ = 0.001 μF) (calculated) = ____________

$f(C$ = 0.01 μF) (calculated) = ____________

Compare the measured and calculated frequencies for both capacitor values.

Part 2. Wien Bridge Oscillator

a. Construct the circuit of Fig. 31.2. (Measure and record the resistor values in Fig. 31.2.)

b. Using the oscilloscope observe and record the output waveform in Fig. 31.6.

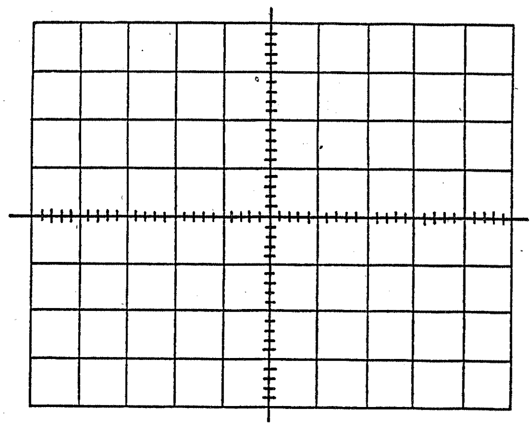

Figure 31-6

c. Measure the time for one cycle.

T (measured) = ____________

d. Determine the signal frequency.

$f = 1/T$ = ____________

e. Change both capacitors to C = 0.01 μF and repeat steps 2(**c**) through 2(**d**).

T (measured) = ____________

$f = 1/T$ = ____________

f. Calculate the theoretical frequency of the oscillator for each capacitor value.

$f(C = 0.001\ \mu F)$ (calculated) = ____________
$f(C = 0.01\ \mu F)$ (calculated) = ____________

Compare the calculated frequencies for both capacitor values with those measured.

Part 3. 555 Timer Oscillator

a. Construct the oscillator circuit of Fig. 31.3. (Measure and record the resistor values in Fig. 31.3.)

b. Observe and record the output waveforms at pins 3 and 4 in Fig. 31.7.

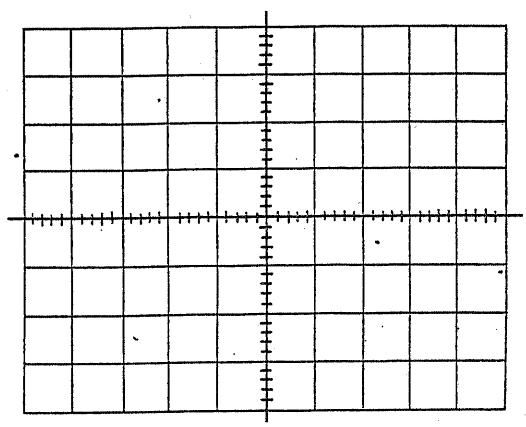

Figure 31-7

c. Measure the period of the output waveform.

T (measured) = ____________

d. Determine the signal frequency.

$f = 1/T =$ ____________

e. Replace the capacitor with $C = 0.01\ \mu F$, and repeat steps 3(**c**) through 3(**d**).

T (measured) = ____________

$f = 1/T =$ ____________

f. Calculate the value of coefficient k using the measured values of f, R and C.

k (measured) = ____________

Use the value of k to calculate the theoretical value of frequency with the $C = 0.01\ \mu F$ capacitor.

f (calculated) = ____________

Compare the calculated value of f for $C = 0.01\ \mu F$ with that measured.

Part 4. Schmitt-Trigger Oscillator

a. Construct the oscillator circuit of Fig. 31.4. (Measure and record the resistor value in Fig. 31.4.)

b. Observe and record the output waveforms at pins 1 and 2 in Fig. 31.8.

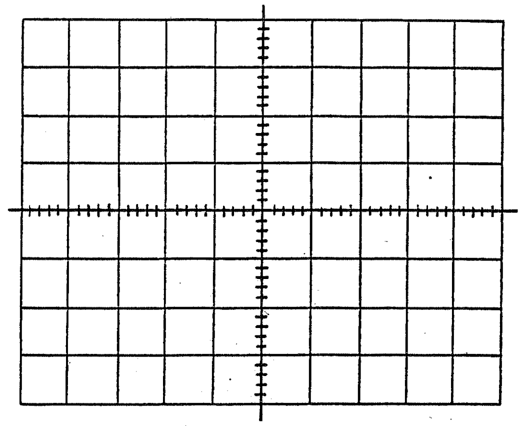

Figure 31-8

c. Measure the period of the output waveform.

T (measured) = ____________

d. Determine the signal frequency.

$f = 1/T$ = ____________

e. Replace the capacitor with C = 0.01 μF, and repeat steps 4(**c**) through 4(**d**).

T (measured) = ____________

$f = 1/T$ = ____________

f. Calculate the theoretical frequency, f, using Eq. 31.5 for each of the capacitor values.

$f(C = 0.001\ \mu F)$ (calculated) = ____________

$f(C = 0.01\ \mu F)$ (calculated) = ____________

Compare the calculated value of f for each capacitor with those measured.