TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI

VICTORIA

UNIVERSITY OF WELLINGTON

Laboratory Instructions

Course Number:	XMUT204
Laboratory Number:	3
Laboratory Title:	Diode Applications
1. Working with the clipper and clamper circuits. 2. Measuring the characteristics of zener diode based circuits.	

Name: ______________________________

Student Number: _________________________

Objectives

- Working with diode clipper and clamper circuits.
- Measuring the characteristics of zener diode.
- Measuring voltage regulation.

Part A: Clipper & Clamper Circuits

A1. A Diode Clipper

Diodes may be used in a number of ways to change the shape or form of a signal. For example, the diode clipper of Fig. 1a may be used to limit the amplitude of an ac signal.

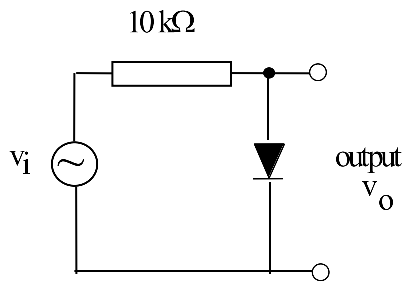

Fig. 1a: Clipper circuit

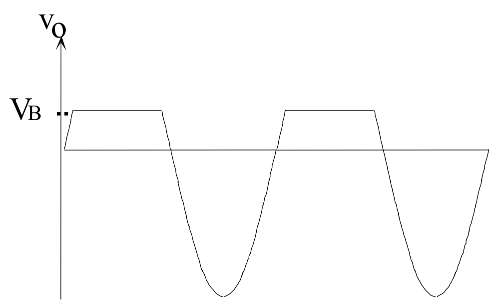

Fig. 1b: Clipper waveforms

a. Set up the circuit of Fig. 1a. Use the signal generator at 1 kHz to provide an input sinusoidal signal at 8 V_{pp}. Display both v_i and v_o on the oscilloscope (use dc coupling). The output v_o should be as shown in Fig 1b.

b. Using the constant drop model for the diode (see Lab 2 handouts) explain this result.

c. Insert the dc power supply (set to 2V) between the diode and ground as shown in the Fig. 2 given below.

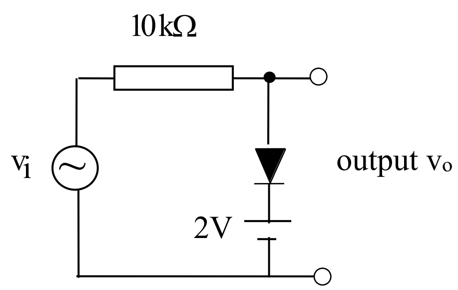

Figure 2: Clipper circuit (+ voltage source)

d. Sketch v_o and explain its form.

e. Remove the dc power supply and reverse the diode. Sketch v_o and explain its form.

A2. A Diode Clamper

Diodes may be used to control the peak values of an ac signal in a circuit, i.e. to hold (clamp) its dc level at a predetermined value.

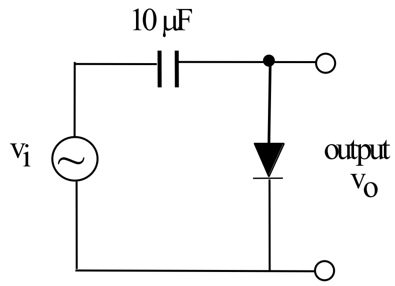

Figure 3: Clamper circuit

a. Replace the 10 kΩ resistor in Fig. 1a with a 10 μF capacitor (Fig. 3); again use dc coupling on the oscilloscope coupling.

b. Sketch v_i and v_o. Measure (using the DVM) the voltage drop V_c across the capacitor and explain the operation of the circuit.

Note:

- As v_i initially goes positive, the diode conducts and the capacitor is charged up; when v_i starts to fall from its peak value, the diode becomes reversed biased and the capacitor cannot discharge.
- $v_o = v_d = v_i - V_c$

Part B: Zener Diode

Introduction to Zener diodes

If a sufficiently large reverse bias is applied to a semiconductor diode, a significant current will start to flow at the "breakdown" voltage. Zener diodes are manufactured to withstand this breakdown effect up to some specified power rating. They are used as voltage regulators.

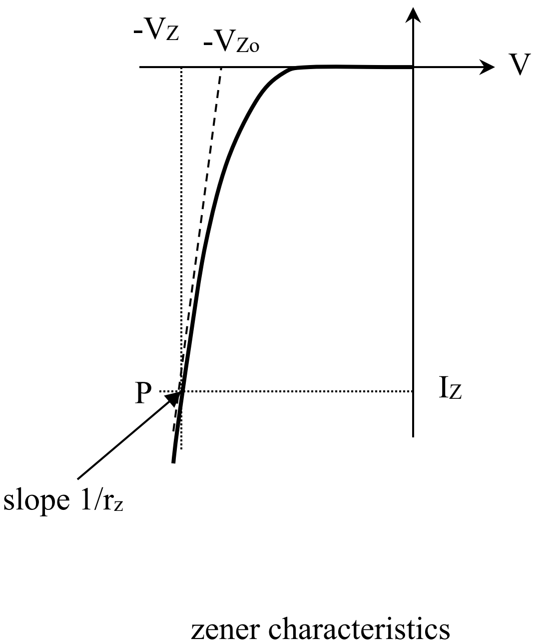

Fig. 4a: Zener diode V-I curve

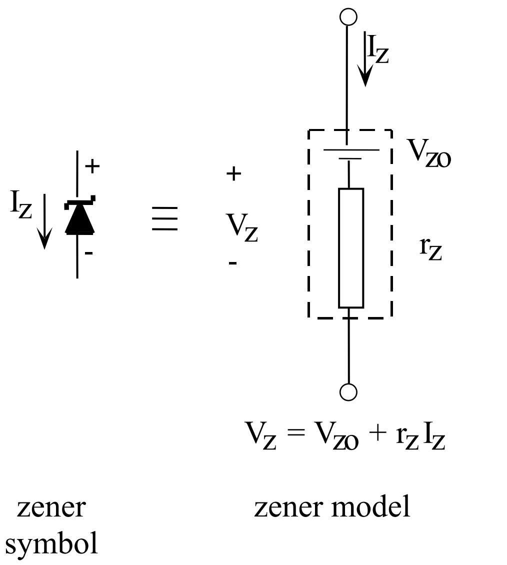

Fig. 4b: Zener diode model

The I-V characteristics in the breakdown region are shown in Fig. 4a.

A zener is specified by its voltage V_Z at some test current I_Z (point P), its power rating and its incremental resistance r_Z , the inverse of the slope of the characteristic at I_Z . This line cuts the V axis at V_{ZO}. The I-V relationship may be modelled by the combination of a voltage source V_{Zo} and resistance r_Z shown in Fig. 4b.

B1. Measuring the Characteristics of a (Nominal) 3.3 V Zener (IN746A)

a. Set up the circuit of Fig. 5.

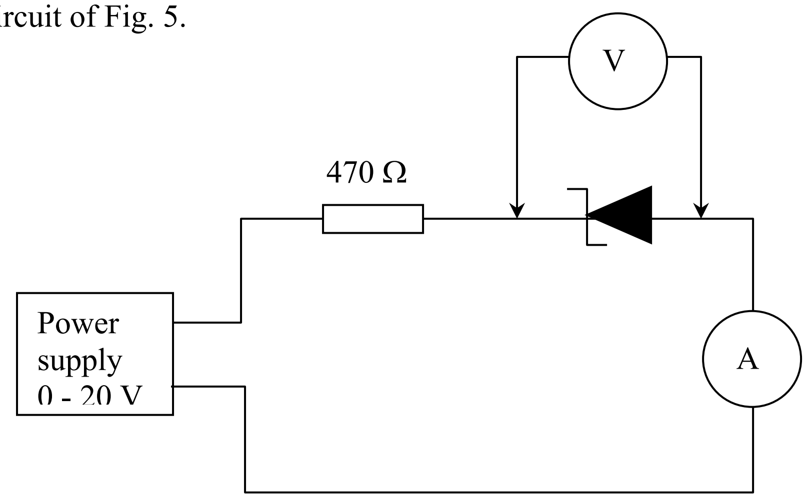

Fig. 5: Zener diode measurement circuit

b. Record values of Vz for the following values of Iz (in mA): -3, -6, -10, -15, -17.5, -20, -22.5, and -25.

Vz	**Iz**
-3	
-6	
-10	
-15	
-17.5	
-20	
-22.5	
-25	

c. Plot Iz against Vz. For a value of I_z =-20 mA, determine r_z and V_{zo} (Fig. 4a).

B2. Measuring Voltage Regulation

a. For the circuit of Fig.5, measure the change in V_Z when the voltage supply is changed from +12 to +14 V.

Calculate the change in the output / the change in the input. This is known as the *line stability ratio*.

b. By modelling the zener diode as shown in Fig. 4b, calculate (using your measured values for r_z) what you would expect the line stability ratio to be. Compare your result with this value.

Part C: Report

Complete a short report by answering the questions from the associated question sheet.

Equipment

Resistor:	470Ω, 10kΩ, 100kΩ, and 1MΩ
Capacitor:	10 uF
Diode:	1N4148, 1N746A (3.3 V)

- End of laboratory -