Name: ___

ECET 242 – Electronic Circuits

Lab 2 Oscilloscope Measurements

- **Objective:** Students successfully completing this lab exercise will accomplish the following objectives:
 - 1. Learn how to use an oscilloscope for voltage measurement and display of time-varying signals.
 - 2. Learn how to construct a half-wave rectifier circuit using a single diode.
- Lab Report: An informal lab report will be required for this experiment. Turn in this handout with your collected data and waveform sketches. Reports will be due at the next lab session following the date on which the lab was performed.

| Equipment: | Oscilloscope | 2 kΩ resistor |
|------------|----------------------|------------------|
| | Function Generator | Breadboard |
| | 1N4004 silicon diode | Connecting leads |

Procedure 1: Measurement of a Sine Wave

- 1. Turn on the oscilloscope.
- 2. Use the following steps for basic setup for measurement and display of time varying signals. Adjust the control knobs of the oscilloscope as described below.

In the horizontal mode shaded area:

- Press the A enable button
- Set the A TIME/DIV knob to 2 ms per division.

In the vertical mode shaded area:

- Press the CH1 enable button
- Set the CH1 VOLTS/DIV knob to 5 volts per division.
- Turn the inner CH1 VOLTS/DIV knob fully clockwise to the CAL position.
- Set the three position CH1 switch to ground (GND).
- Adjust the CH1 position knob until a horizontal green line appears. Use the knob to align the green line with the x-axis.

In the TRIGGER shaded area:

- Notice that you have four columns of buttons (SLOPE, MODE, SOURCE, COUPLING).
- Set trigger slope to +.
- Set trigger source to CH1.

In the INTENSITY shaded area:

• Adjust the A&B knob for the desired intensity of the input waveform

In the FOCUS shaded area:

- Adjust the FOCUS knob for the desired clarity of the input waveform.
- 3. You should see an illuminated green horizontal line in the middle of the oscilloscope display. If you do not, ask the instructor for assistance.

- 4. Turn on the function generator and adjust it as follows.
 - Set the waveform type to be a sine wave.
 - Press the ×1k range button. This will be your frequency multiplier.
 - Use the COURSE and FINE frequency control knobs to set the display to 1 (one).
 - Turn the variable attenuation (OUTPUT LEVEL knob) fully counter-clockwise.

You should now have the function generator set to create a 1000 Hz sine wave.

- 5. Using the connection leads and the CH1 probe, connect the red function generator output to the CH1 input of the oscilloscope. Make sure the switch on the CH1 probe is set to x1. Make sure the positive side of the function generator output is connected to the CH1 probe. If all the AC test equipment shares the same power strip and all have a 3-prong AC plug, it is not necessary to ground the alligator clip on the CH1 probe.
- 6. Turn on the function generator and set the oscilloscope's 3-position CH1 switch to AC.
- Adjust the function generator's variable attenuation (OUTPUT LEVEL knob) until you observe a 10 V peak-to-peak sine wave on the oscilloscope. If you do not see a stationary sine wave, adjust the trigger level using the knob in the upper right corner of the oscilloscope.
- 8. Adjust the oscilloscope's outer TIME/DIV knob until you see at least one cycle but no more than two cycles of the sine wave. The oscilloscope screen is broken into grid lines spaced 1 cm apart. Record the distance in cm for the horizontal axis to cover one cycle and the setting of the time per division in the table below.

Distance for one cycle = _____ divisions

Time per division = ms

Since each division is 1 cm wide, you can multiply the distance for one cycle in cm by the time per division in ms to calculate the period (T) of the sine wave in ms. Also, calculate the frequency (f) in Hz (where f = 1/T). Record your calculations and results below.

Calculated period (T) = _____ ms

Calculated frequency (*f*) = _____ Hz

Below, sketch several cycles of the waveform. Label the horizontal and vertical axes and indicate the scale of each.



Procedure 2: Measurement of a Repeated Pulse Waveform

- 9. Turn off the function generator and disconnect it from the oscilloscope.
- 10. Have one lab partner hold the CH1 probe up toward the florescent lights and the other partner adjust the oscilloscope to observe the emission from the ballast of the lights.
- 11. The person adjusting the oscilloscope should make the following adjustments:

In the vertical mode shaded area:

- Set the 3-position CH1 switch to AC.
- Adjust the outer CH1 VOLTS/DIV knob (outer knob) fully clockwise to maximum sensitivity.

In the horizontal mode shaded area:

- Set the A TIME/DIV knob (outer knob) so that you can observe at least one cycle of the pulsed waveform.
- If you do not see a periodic stationary waveform, adjust the trigger level (top right outer button) until the waveform appears.

Measure the horizontal distance between successive positive peaks. Measure the horizontal distance for one cycle and the time per division. Record the data below.

Horizontal distance for one cycle = _____ cm

Time per division = _____ ms

Multiply the two quantities above to calculate the period (T) of the pulse in ms. Calculate the frequency (*f*) in Hz (where f = 1/T). Record your calculations and results below.

Period of a pulse = _____ ms

Pulse repetition frequency = _____ Hz

Measure the peak-to-peak vertical distance of the signal and record the voltage per division. Multiply the two quantities and calculate the peak-to-peak voltage of the observed signal.

Peak-to-peak vertical distance = _____ cm

Voltage per division = _____ mV

Calculated peak-to-peak voltage = _____ mV

Below, sketch several cycles of the repetitive pulse waveform. Label the horizontal and vertical axes and indicate the scale of each.

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| Figure 2 | Repetitive pulse waveform | n sketch |
| rigure 2 | | |
| ES: Vertical | V/Div, Horizont | al |

12. Set the trigger slope to +. Stretch out the waveform using the A TIME/DIV knob. Adjust the trigger level so that you see a leading positive pulse. Go back and adjust the A TIME/DIV knob if necessary to see a full positive pulse stretching out over at least 1 cm. Record settings below and calculate the pulse width.

Horizontal distance at the base of the pulse = _____ cm

Time per division = _____ ms

Calculated pulse width = _____ ms

Below, sketch your waveform. Label the horizontal and vertical axes and indicate the scale of each.



Procedure 3: Half-Wave Generator Circuit

- 13. Set the signal generator as in the first section to generate a 1000 Hz waveform, 10 V peakto-peak. Set the CH1 3-way switch to DC. Connect and adjust the oscilloscope to observe several cycles of the sine wave.
- 14. Build a series circuit consisting of a 2 k Ω resistor in series with a 1N4004 diode as shown below.



Figure 4: Half wave rectifier circuit

- 15. Connect the CH1 probe to measure the diode voltage. Make sure the n-side of the diode is connected to the negative side of the function generator. The oscilloscope should display a half-wave sinusoid.
- 16. Set the CH1 3-way switch to GND (ground). Adjust the CH1 horizontal position so that the line is aligned with the x axis. This will calibrate the zero volt axis of the waveform to the screen's x axis.
- 17. Set the CH1 3-way switch to DC. Use the oscilloscope to measure the peak reverse diode voltage.

Peak reverse diode voltage = _____ V

Use the oscilloscope to measure the peak forward diode voltage. Expand the vertical scale as necessary to get an accurate measurement.

Peak forward diode voltage = _____ V

Below, sketch several periods of the half-wave signal of the diode voltage. Label the horizontal and vertical axes and indicate the scale of each.

