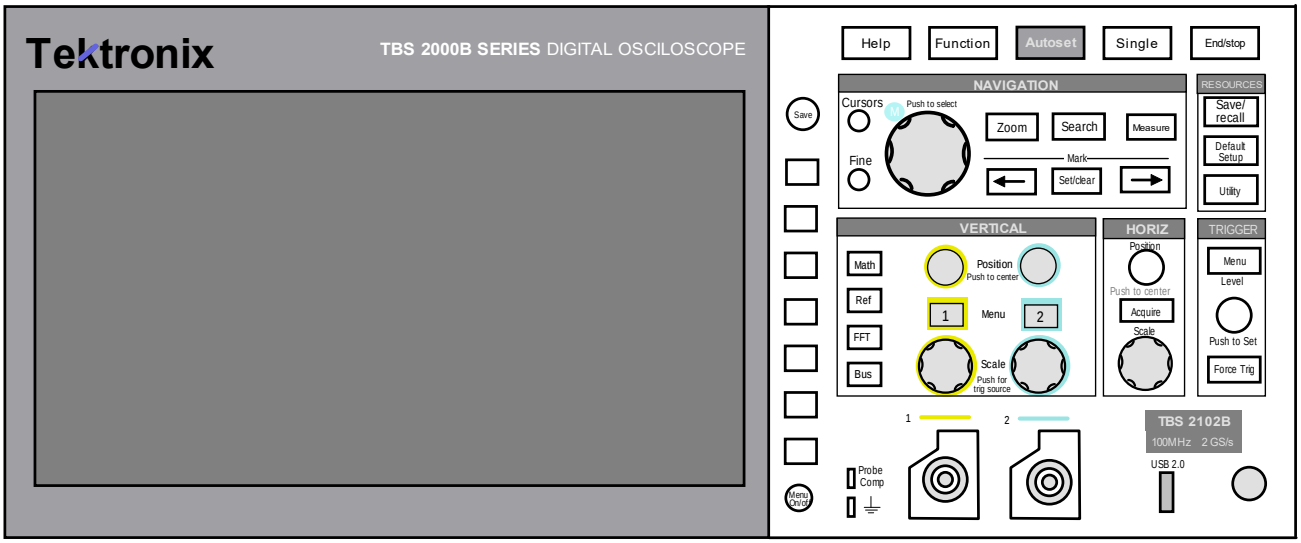
Electric Circuits Laboratory

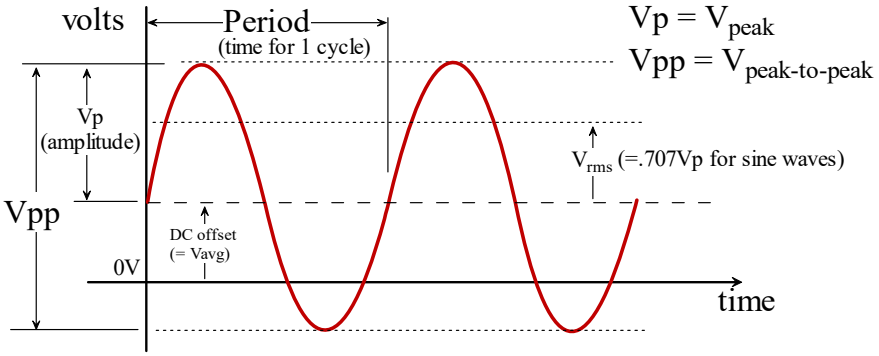
ENGR 250L - LAB EXERCISES

LAB 4 - SCOPE, FG I (1.7h)



The oscilloscope ("scope") and function generator ("FG") are standard tools for a circuits lab. Here we will learn the basics of their function and use. Refer to the **CT GUIDE** about the basics of what scopes and function generators do and how they work before doing this lab.

The scope and FG are critical when working with AC circuits. The digital scopes an display a variety of measurements. The figure below will help you to visualize what these parameters are for a sine wave.



4.1 EQUIPMENT LIST

1. Oscilloscope ("scope") (Tektronix TBS 2000B (60 MHz, 1 GSa/s)
2. Function generator ("FG") (BK Precision 4011A (5 MHz))
3. Scope probes (x2)
4. Scope calibration screwdriver (small)
5. Co-ax cables with BNC connectors (for FG) and/or "break out" alligator clips

6. USB Flash Drive (formatted as FAT32 **UPDATE**) (STUDENTS MUST BRING from now on!)

4.2 SCOPE SET UP

STEPS

1. Reset scope to factory settings.
2. Adjust PROBE COMPENSATION (refer to the **CT GUIDE**).
3. Set PROBE ATTENUATION (10x for both scope & probe) (refer to **CT GUIDE**)

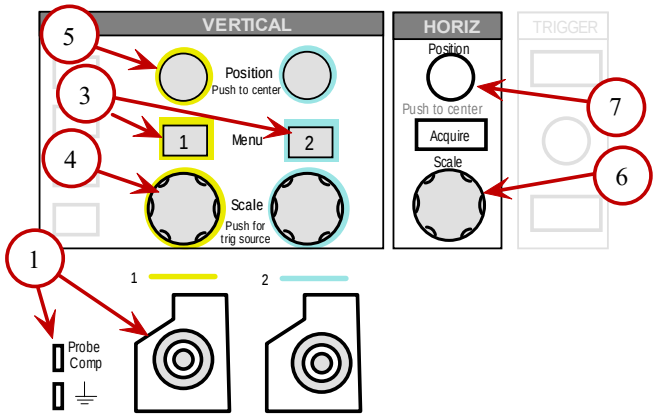
4.3 COPY TRACE TO FLASH DRIVE

Digital storage oscislloscopes (DSO's) can usually save a digital copy of the trace. We will do that here.

STEPS

1. Verify probe compensation and attenuation are set beforehand.
2. Connect the CH 1 probe to the probe compensation output.
3. Press AUTOSET
4. (***) Capture the trace screen (refer to CT GUIDE). Use 2nd option - capture trace with "Ink Saver" OFF. Then open file in graphics program like MS PAINT. Highlight ALL, then INVERT COLOR (giving white background). Then paste into MS Word. Pics from a smart phone or camera will lose points.

4.4 BASIC SCOPE CONTROLS



Oscilloscopes have numerous buttons and knobs. Here we will learn about the basic controls on the scope. Here we will learn how to toggle the scope channels on and off, change the voltage and time scales, and adjust the horizontal and vertical position of the traces. Also there is AUTOSET, which will automatically adjust the voltage and time scales. Be careful. Many students overuse this function. It can be helpful, but many times it will not cause the trace to display as desired.

STEPS

1. Connect CH 1 to the probe compensation signal.
2. Adjust the probe compensation and attenuation (hopefully you already did that above).
3. (***) Now press CH 1 and CH 2 again and again. What do those buttons do?
4. (***) With CH 1 on, turn the SCALE knob. What does it do?
5. (***) Turn the VERTICAL POSITION knob. What happens to the trace?

6. (***) Turn the HORIZ SCALE knob. What does it do?
7. (***) Turn the HORIZ POSITION knob. What happens to the trace?

4.5 TRIGGER, COUPLING, MEASURE

Other essential scope controls are: TRIGGERING, COUPLING, and MEASUREMENTS

4.5.1 Coupling

There are usually 3 coupling modes: AC, DC, and GND (refer to **CT GUIDE**)
AC - an AC signal with DC offset is displayed WITHOUT the DC offset.
DC - an AC signal with DC offset is displayed WITH the DC offset.
GND - the scope show nothing, just a horizontal line at 0 V.

STEPS
1. Use the probe compensation signal into CH1. Press AUTOSET.
2. (***) Change the OFFSET to AC, DC, and then GND. Capture the trace for each setting.
3. (***) Describe the difference between AC and DC coupling?
4. (***) Is the probe compensation signal centered at 0 volts?

4.5.2 Trigger

Scopes use TRIGGERING to get oscillating signals to appear static on the screen. The trigger setting specifies which channel you are triggering off of, and the trigger "level", which is basically the voltage value that will be placed on the y axis.

STEPS
1. Use the probe compensation signal into CH 1. Press AUTOSET.
2. Set coupling to DC.
3. Adjust the trigger level to a value beyond the height of the signal (a "wrong trigger level")
4. (***) What happens to the trace?
5. Return the trigger level back to where it was before.

4.5.3 Measurements

With analog scopes, you must figure out frequency and voltage values by counting divisions. Digital scopes will calculate and display these values for you. To display any voltage or time parameters, perform the following steps: Press MEASURE > Add measurement (lower left, use bottom menu keys) > V/I Mean (use side menu keys) > select Pk-Pk (turn VARIABLE knob) > Press SELECT button (under VARIABLE knob). Press Menu Off to remove menu items. **UPDATE**

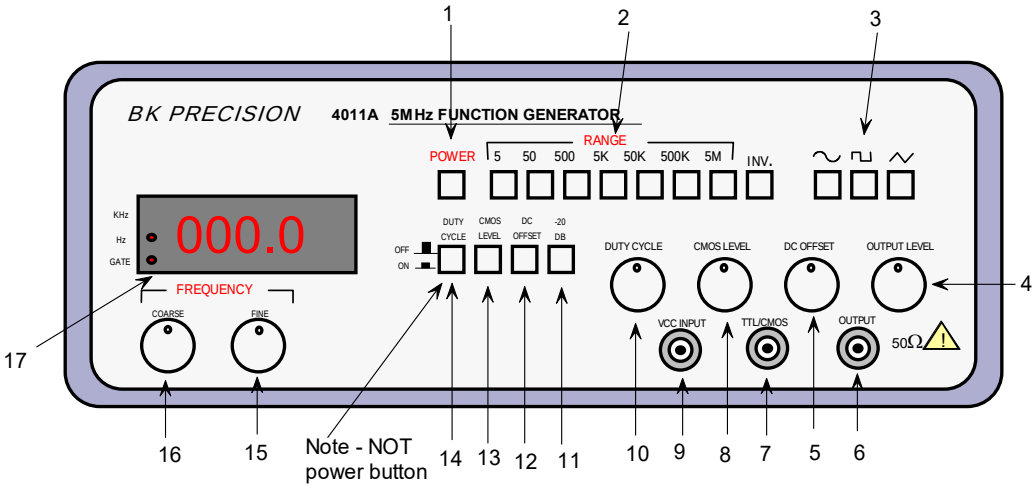
STEPS
1. Again use the probe compensation signal into CH 1.
2. (***) Display the following measurements: Vpeak-to-peak, V(avg or mean). Capture the screen.

4.6 FUNCTION GENERATOR

Function generators produce voltage waveforms such as sine waves or square waves. They are signal PRODUCING devices. A function generator has the ability to change various parameters such as: wave type, frequency, amplitude, offset, duty cycle, and phase.

4.6.1 BK Precision 4011A

The BK Precision is a bench style function generator with a single output.



STEPS

1. Get the FG to produce a SQUARE wave (1 kHz, 4 Vpp, 0 offset)
2. Display the signal on the scope. Use "OUTPUT" BNC connector on far right (NOT any of the others).
3. Now adjust the FG to reduce the wave to 2 Vpp. Note - the FG will not be able to! First you must press the "-20 dB" button, then re-adjust the output level.
4. Now get the FG to produce a sine wave (1 kHz, 2 Vpp, 0 offset) (you may need to un-press "-20 dB")
5. Display the signal on the scope.
6. Display the following measurements (Vpp, Vavg, Vrms)
7. (***) Capture the screen, including measurements.

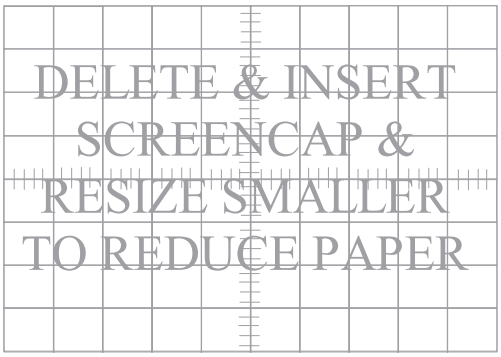
LAB 4 - ANSWER SHEET

SCOPE FG I

Team Number: _____

Name 1: _____ Name 2: _____

4.3 Capturing traces



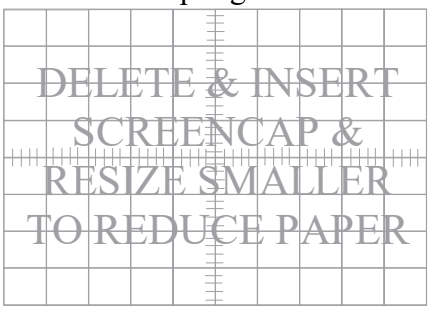
Probe Compensation Signal

4.4 Scope Controls - what do the knob/buttons do?

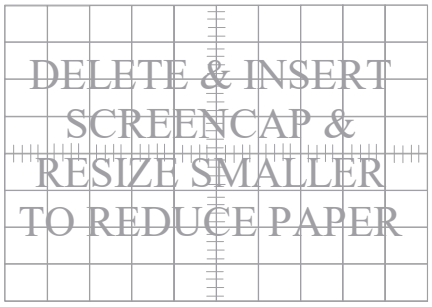
1. _____. CH 1 button
2. _____. CH 2 button
3. _____. VERT SCALE knob
4. _____. VERT POSITION knob
5. _____. HORIZ SCALE knob?
6. _____. HORIZ POSITION knob

4.5.1 Coupling

AC coupled



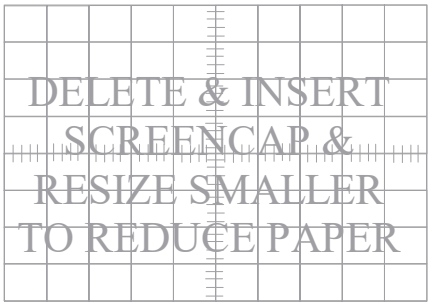
DC coupled



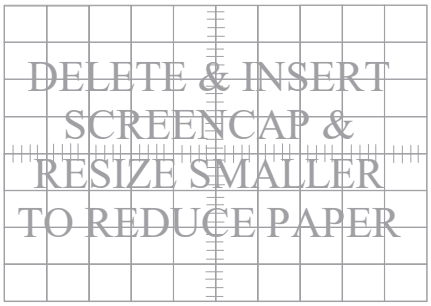
GND coupled

Is probe compensation signal centered at 0 V?_____.

4.5.2 Wrong trigger level - what happens?:_____.



4.5.3 Show measurements (probe compens)



4.6.1 Sine Wave w/ Measurements