Basic Elec. Engr. Lab

ECS 204

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Practice Session for the final exam

Announcements

- You are free to choose any bench today.

Final Exam

- April 27, 2015
- Read the instructions and the questions carefully.
- **Closed book. Closed notes**.
- **No calculators**.

Sessions

- April 27, 2015
- 60 Minutes
  - Check your group assignment.
  - **Group a**: 9:30 – 10:30 PM
    - Do not leave the exam room until the end of the allotted time.
  - **Group b**: 10:40 – 11:40 PM
  - **Group c**: 1:30 – 2:30 PM
    - Do not leave the exam room until the end of the allotted time.
  - **Group d**: 2:40 – 3:40 PM
- Arrive at least 10 minutes early
- Basically same rules as midterm….

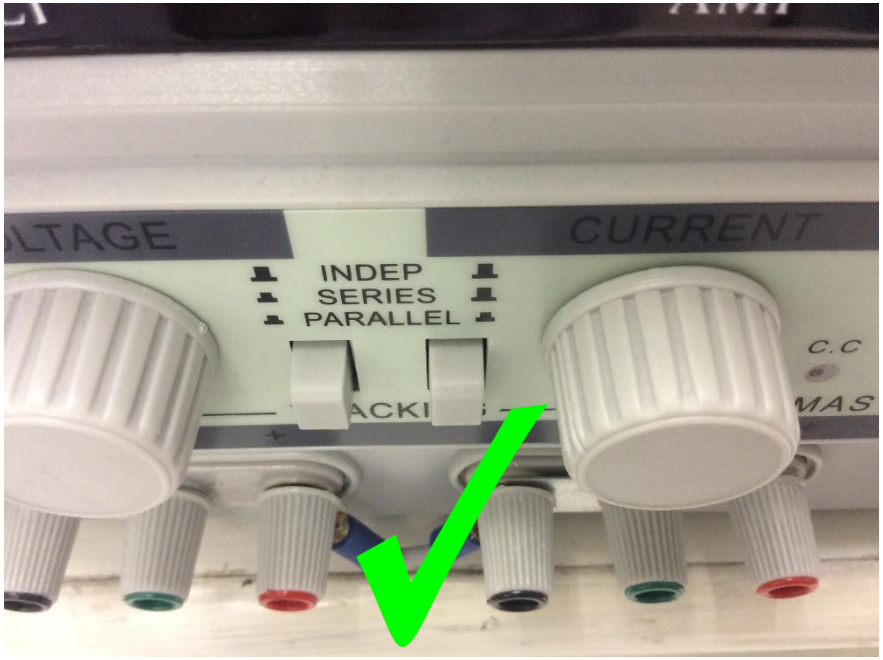
Sec 1			Sec 2	
5422780759	a		5422800680	d
5622780153	b		5622770659	c
5622780427	b		5622770733	d
5622780609	b		5622772093	d
5622781359	b		5622780237	c
5622781565	b		5622780260	c
5622790129	a		5622780310	d
5622790194	b		5622780344	c
5622790244	a		5622780526	d
5622790251	b		5622780799	c
5622790301	b		5622780856	d
5622790566	a		5622780898	c
5622791192	a		5622780906	c
5622791812	b		5622781003	c
5622791838	a		5622781227	c
5622791846	a		5622781615	c
5622792182	b		5622781748	d
5622792281	a		5622782019	d
5622792349	b		5622790582	c
5622792604	a		5622790723	d
5622792950	b		5622790731	d
5622793172	a		5622791424	d
5622793826	a		5622791549	c
5622795012	a		5622791580	d
5622795137	a		5622792067	c
5622795319	b		5622792315	c
5622795459	b		5622792331	c
5622795483	a		5622792455	c
5622795681	b		5622792497	d
5622795723	b		5622792521	d
5622800100	a		5622792539	d
5622800118	a		5622793040	d
5622800472	a		5622793313	d
			5622793578	c
			5622793800	c
			5622794923	d

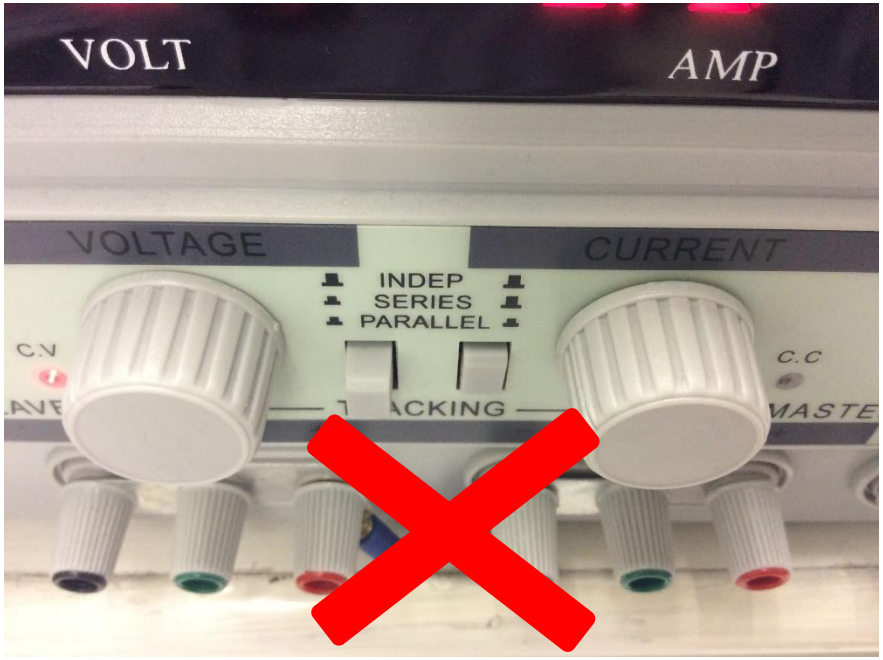
DC Power Supply

- Floating
- Current limit
  - Limit the maximum amount of current supplied by the device.
  - In our experiment, the current is small (mA).
    - So, we set the current limit to be small.
  - There is no further need to adjust these knobs in any experiment except to make sure that the red mark on the knob is located at the white mark.
- The **red light** should be off if you connect the circuit correctly.
  - Turn the power supply off immediately when you see red light. Fix your circuit before you turn the power supply on again.
  - Do not put the DMM in ammeter mode directly across the two power supply terminals.

DC Power Supply (Another Model)

- If you use the digital-display DC power supply, make sure that you use the "INDEP" tracking mode.





DMM in AC mode

RD700

RD700
RD701

High input impedance 1000MΩ

- 3-3 / 4 digits 4000 count
- 0.3% best accuracy
- AC True RMS ※RD701 only
- Capacitance measurement
  ※Not suitable for measurement of condensers with large leak current.
- K type temperature
  ※Optional accessory K-AD is necessary.
  ※K type temp. sensor K-250PC is included as a standard accessory
- Frequency measurement
  ※Input voltage : 20VACrms and under
  ※Input signal : sign wave or square wave with 40%-70% duty
  ※Input sensitivity : 10Hz～20kHz/0.9Vrms and above
  : 20kHz～500kHz/2.6Vp or 1.9Vrms and bove
  : 500kHz～1MHz/4.2Vp or 3Vrms and above
- ADP function (for current sensor)
- Max recording measurement
- Data hold / Range hold ■Relative value
- Auto power off (30min.) (cancelable)
- Alarm for improper test lead insertion to current terminal
- Protective holster with wall hanger and lead holder
- Tilt stand

Display : numeral display 4000 (Hz : 9999, capacitance : 5000)

Sampling rate : 3 times / sec. (Hz : 2 times / sec.)

AC frequency bandwidth : 50～500Hz

RD701 only

RD700 / 701	Measuring range	Best accuracy	Resolution	Input impedance
DCV	400m/4/40/400/1000V	± (0.3%+4)	0.1mV	10M～1000MΩ
ACV	400m/4/40/400/1000V	± (1.5%+5)	0.1mV	
DCA	400μ/4000μ/40m/400m/4/10A	± (1.2%+3)	0.1μA	
ACA	400μ/4000μ/40m/400m/4/10A	± (1.5%+4)	0.1μA	
Resistance	400/4k/40k/400k/4M/40MΩ	± (0.6%+4)	0.1Ω	
Capacitance	500n/5μ/50μ/500μ/3000μF	± (2.5%+6)	0.01nF	
Temperature	-20℃～300℃	± (2%+3)	1℃	
Frequency	50Hz～1MHz	± (0.5%+4)	0.01Hz	
Continuity	Buzzer sounds at between 20Ω and 120Ω. Open voltage : approx. 0.4V			
Diode Test	Open voltage : approx. 1.6V			
Bandwidth	50～500Hz			
Fuse / Battery	12.5A/500V IR20kA φ6.3×32mm 0.63A/500V IR200kA φ6.3×32mm	6LF22 (9V)×1		
Size / Mass	H179×W87×D55mm/460g (including holster)			
Standard accessories included	Test Lead (TL-23a), Thermocouple K type (K-250PC), Holster (H-50), Instruction manual			

Optional accessories

Clamp probe : CL124, CL140, CL-22AD, CL33DC, CL3000
HV probe : HV-60
Temperature probe : K-8-800, K-8-650, K-8-300, K-8-500, K-8-250
K type adapter : K-AD
Test lead : TL-21M, TLF-120
Carrying case : C-CD
Clip adapter : CL-11, CL-13a, CL-15a, CL-DG3a, TL-8IC

DMM: DC vs. AC Modes

- V_{DC} = Measured value of the voltage using DMM in DC mode
  - Theoretically,
    - V_{DC} = Average value = DC offset voltage = DC component

$$V_{DC} = \overline{v(t)} = \frac{1}{T}\int_{t_0}^{t_0+T} v(t)dt$$

- V_{AC} = Measured value of the voltage using DMM in AC mode
  - Theoretically, for "True RMS" DMM,

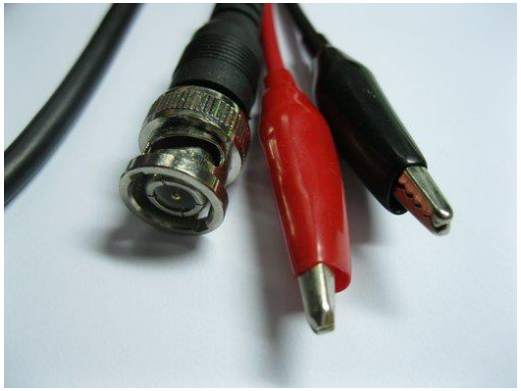
$$V_{AC} = \sqrt{\overline{\left(v(t) - V_{DC}\right)^2}}$$

  - For non-true-rms DMM, the measurement is calibrated so that the above property hold for sinusoids.
- Theoretically,

$$V_{RMS} = \sqrt{\overline{v^2(t)}} = \sqrt{\frac{1}{T}\int_{t_0}^{t_0+T} v^2(t)dt} = \sqrt{V_{AC}^2 + V_{DC}^2}$$

Cables

For function generator,



For oscilloscope,

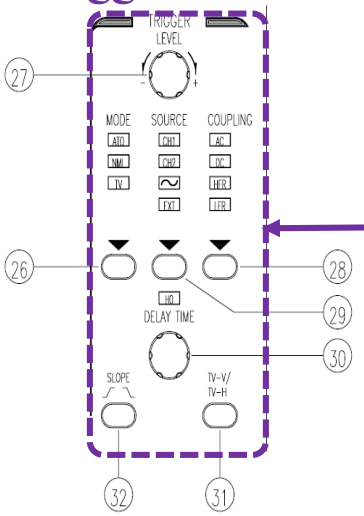
The ×10 mode simply acts as a 10:1 voltage divider for any measured signals. Wit this, you will see tiny signal on the scope.

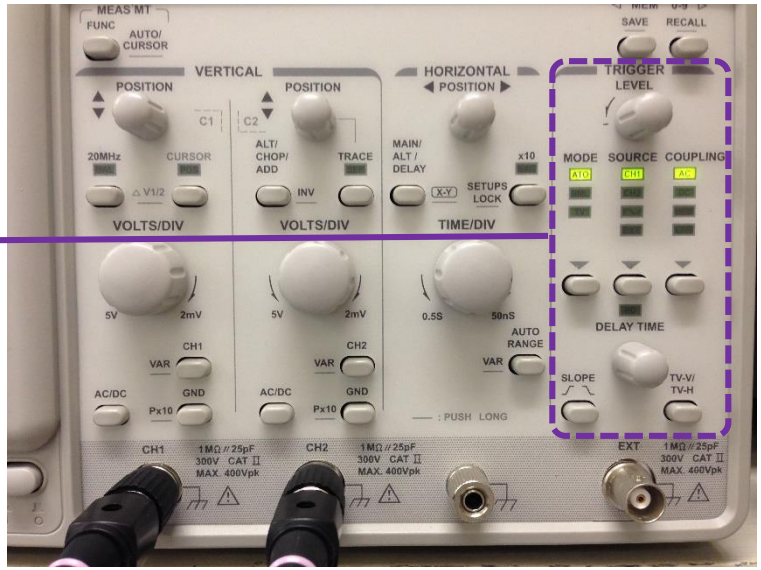
Obviously, one use for a ×10 probe is measuring voltages beyond the normal range of an oscilloscope.

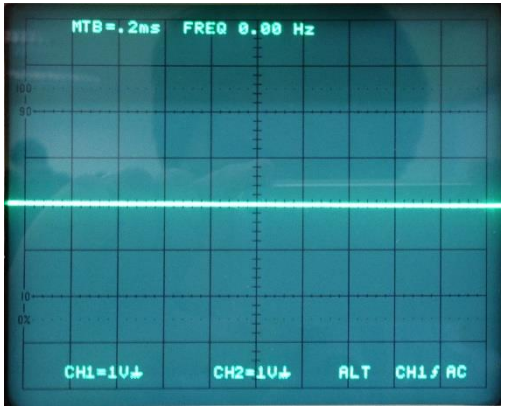
Oscilloscope Preparation

- Make sure that the TRIGGER MODE (26) is set to ATO mode, otherwise the trace will not be shown.
- Use the CH1 and CH2 POSITION controls ((9) and (10)) to align both traces on the center graticule.

Trigger controls

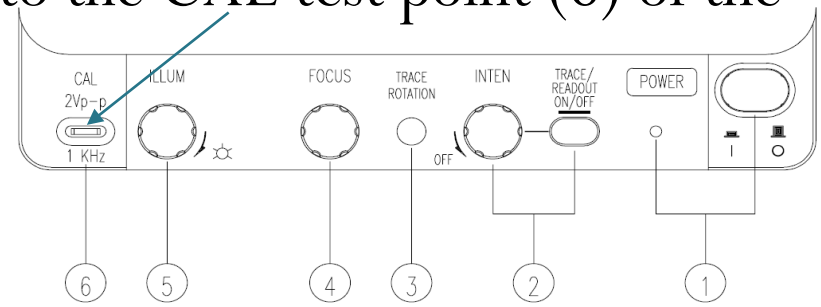




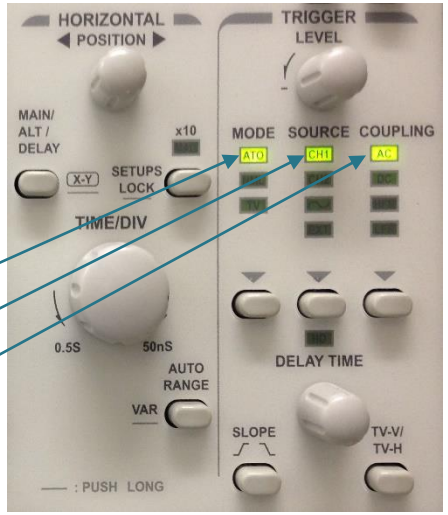


Oscilloscope Preparation

- Connect the probe tips to the CAL test point (6) of the oscilloscope.

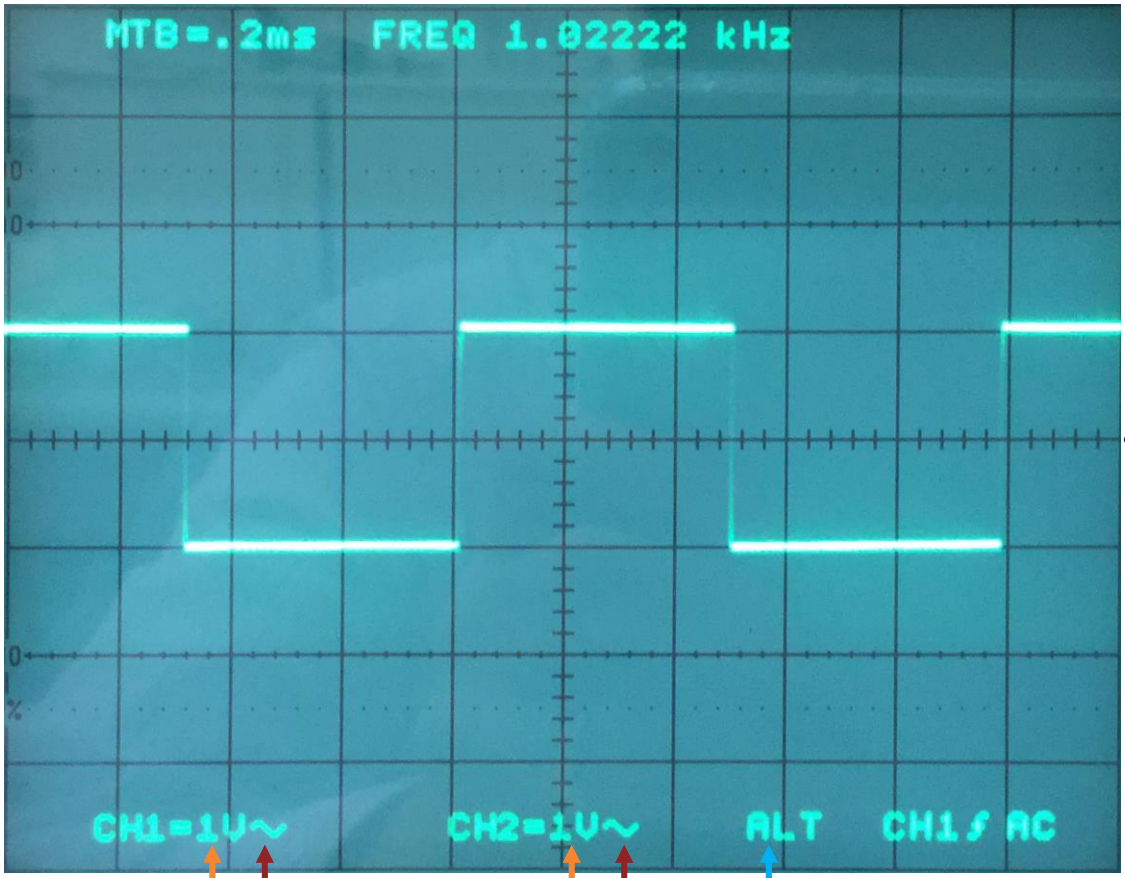


VERTICAL:	VOLTS/DIV ((13) and (14))	1V
	COUPLING ((17) and (18))	DC
	ALT/CHOP/ADD (12)	CHOP or ALT
HORIZONTAL:	MODE (22)	MAIN
	TIME/DIV (21)	0.2ms
TRIGGER:	MODE (26)	ATO
	SOURCE (29)	CH1
	COUPLING (28)	AC



- The square wave of the calibrator signal will be displayed on the screen.

HORIZONTAL:		
	MODE (22)	MAIN
	TIME/DIV (21)	0.2ms

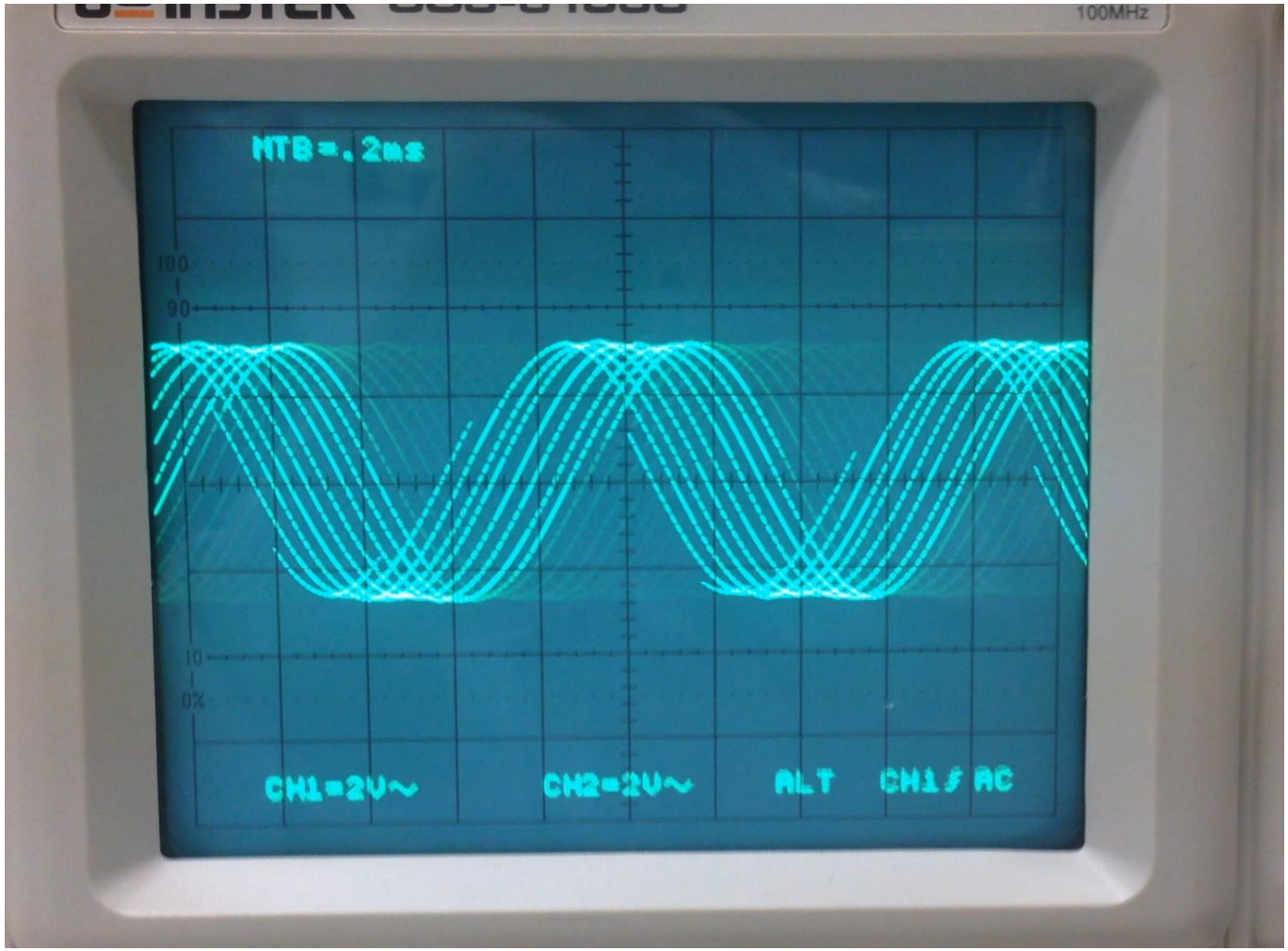


< GND

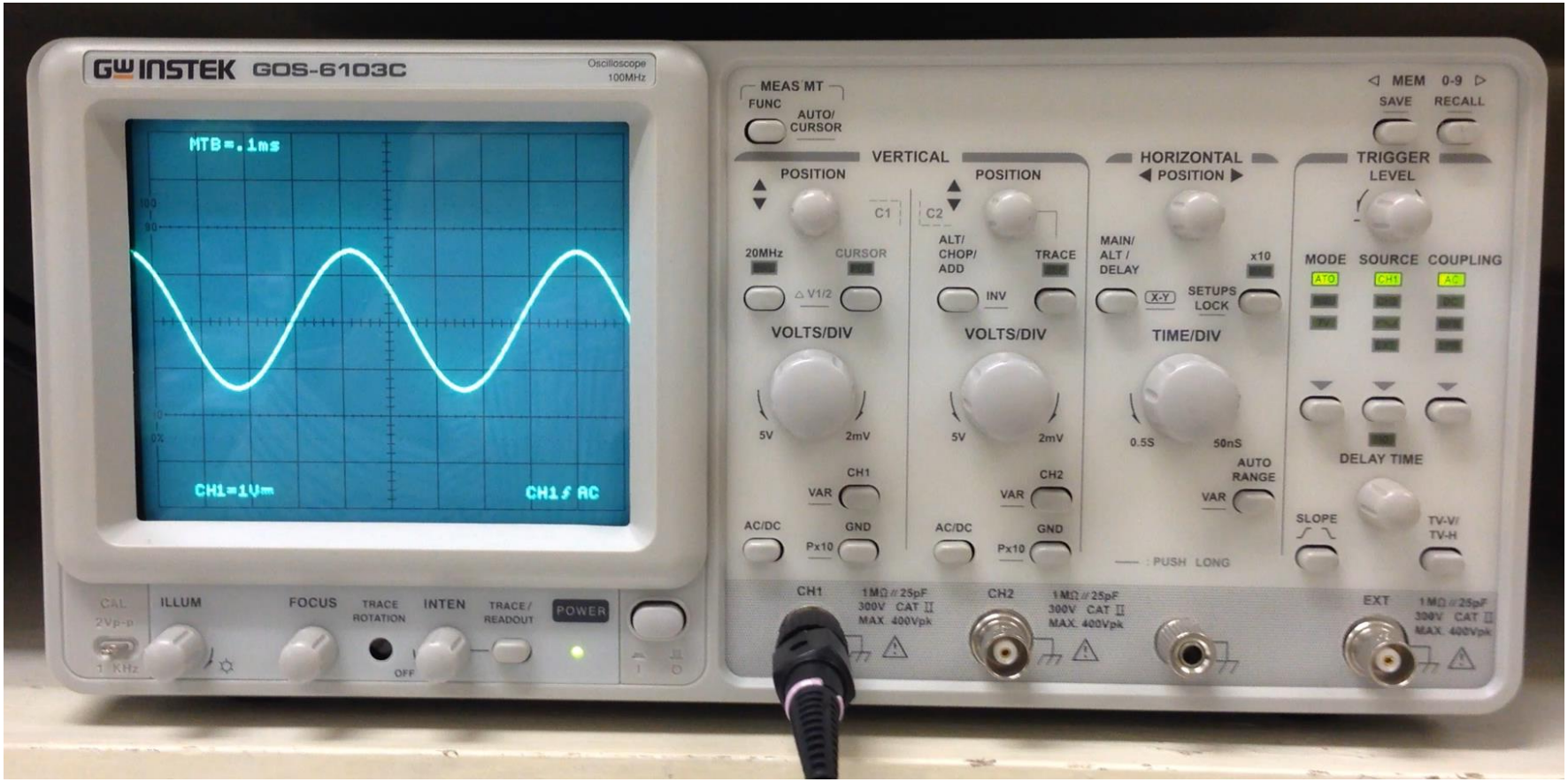
VERTICAL:		
	VOLTS/DIV ((13) and (14))	1V
	COUPLING ((17) and (18))	AC
	ALT/CHOP/ADD (12)	ALT

Triggering

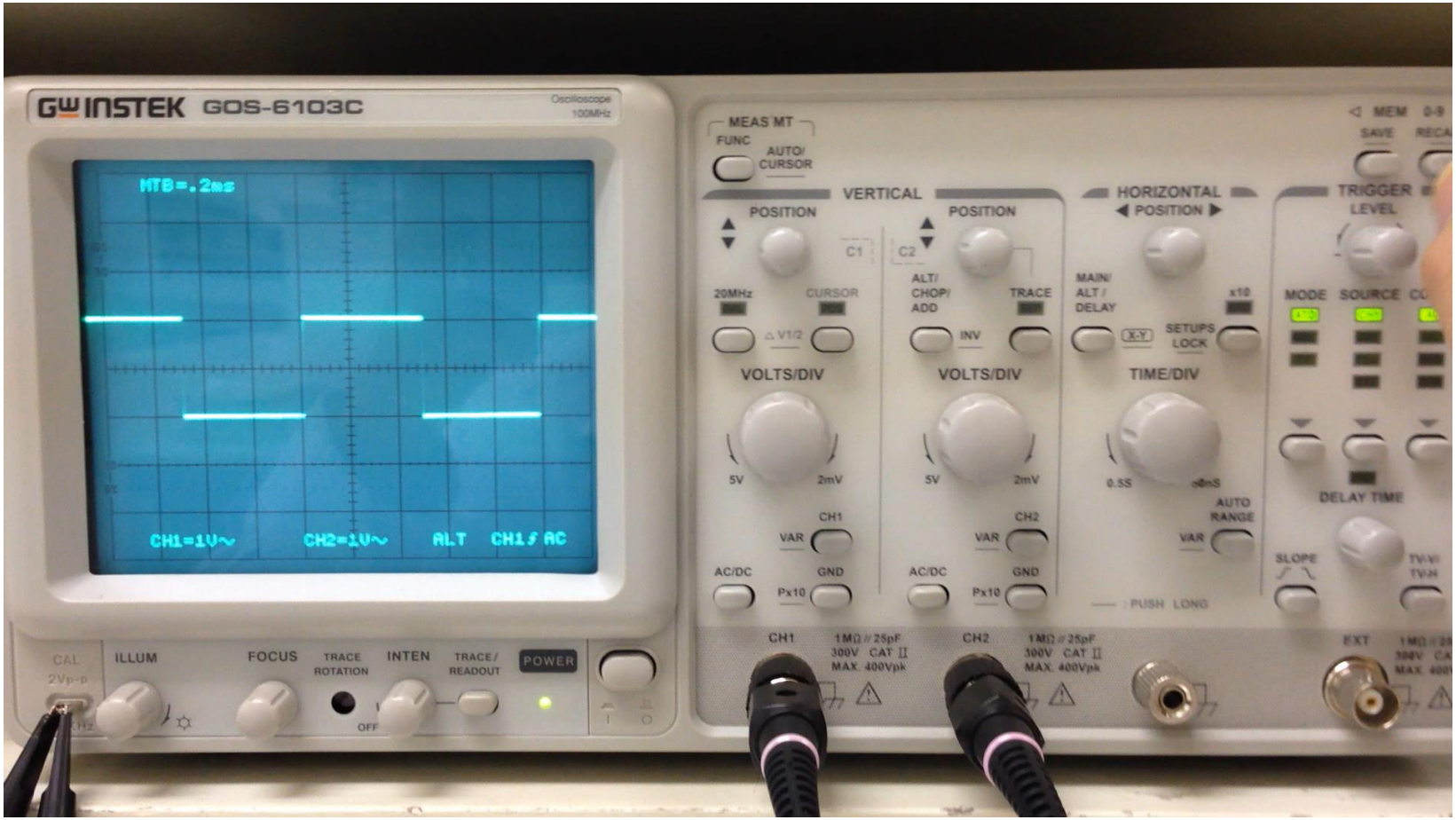
Here, originally, the trigger level was set too high at around 5V so the trigger mechanism can't "see" the signal.
We then use the trigger level knob to adjust the trigger level to around 2.8V which stabilizes the display.



Triggering

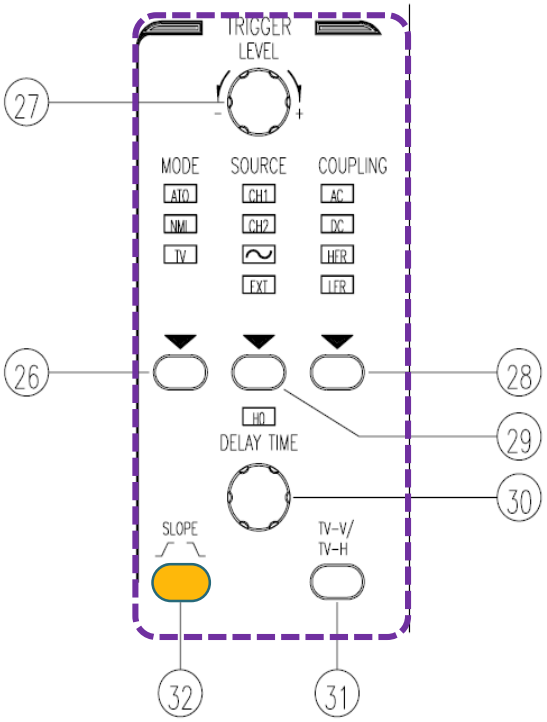

GW INSTEK GOS-6103C
Oscilloscope
100MHz
MTB=.1ms
CH1=1Vm
CH1 ƒ AC
MEAS MT
FUNC
AUTO/
CURSOR
MEM 0-9
SAVE
RECALL
VERTICAL
POSITION
C1
C2
HORIZONTAL
POSITION
TRIGGER
LEVEL
20MHz
CURSOR
ALT/
CHOP/
ADD
TRACE
MAIN/
ALT /
DELAY
x10
MODE
SOURCE
COUPLING
INV
X-Y
SETUPS
LOCK
VOLTS/DIV
VOLTS/DIV
TIME/DIV
5V
2mV
5V
2mV
0.5S
50nS
CH1
VAR
CH2
VAR
AUTO
RANGE
AC/DC
GND
Px10
AC/DC
GND
Px10
DELAY TIME
SLOPE
TV-V/
TV-H
PUSH LONG
CAL
2Vp-p
1 KHz
ILLUM
FOCUS
TRACE
ROTATION
INTEN
TRACE/
READOUT
POWER
OFF
CH1
1MΩ // 25pF
300V CAT II
MAX 400Vpk
CH2
1MΩ // 25pF
300V CAT II
MAX 400Vpk
EXT
1MΩ // 25pF
300V CAT II
MAX 400Vpk

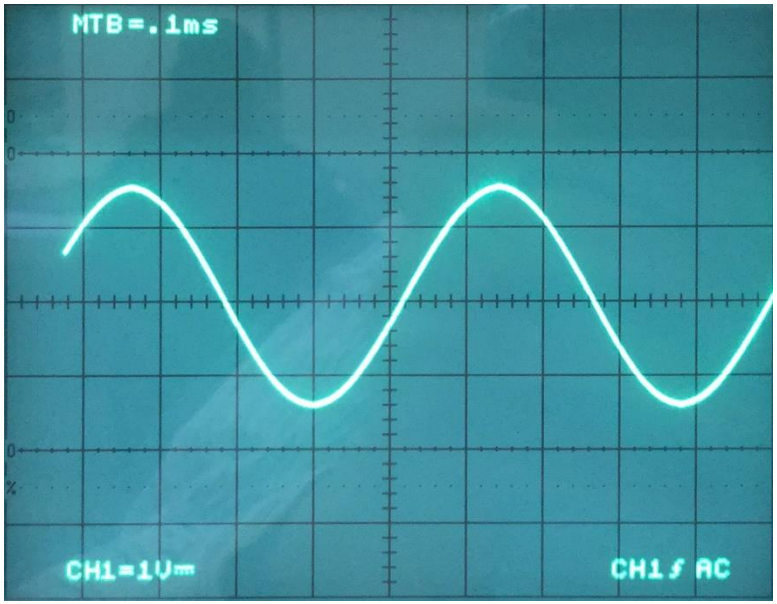
Triggering

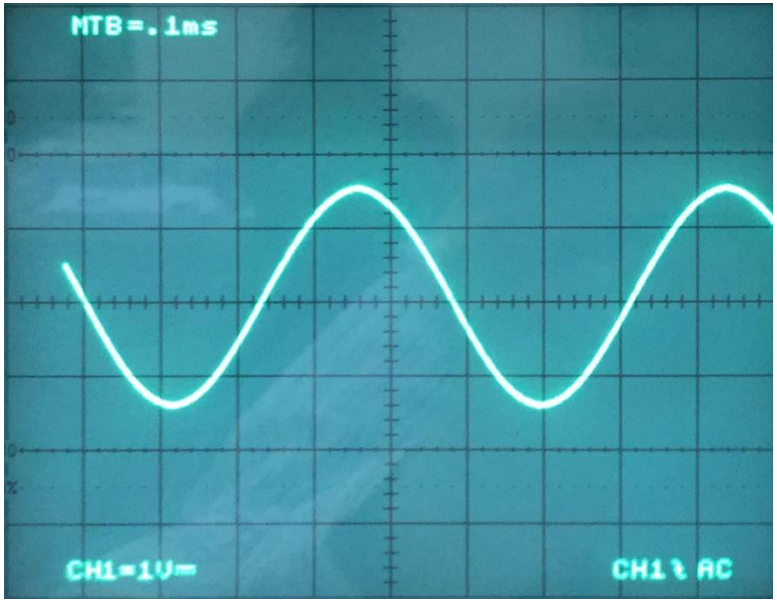

GW INSTEK GDS-6103C
MTB=.2ms
CH1=1V~
CH2=1V~
ALT
CH1 AC
MEAS MT
FUNC
AUTO/
CURSOR
VERTICAL
POSITION
POSITION
HORIZONTAL
POSITION
TRIGGER
LEVEL
20MHz
CURSOR
ALT/
CHOP/
ADD
TRACE
MAIN/
ALT /
DELAY
x10
INV
SETUPS
LOCK
VOLTS/DIV
VOLTS/DIV
TIME/DIV
MODE
SOURCE
DELAY TIME
CH1
VAR
CH2
VAR
AUTO
RANGE
AC/DC
GND
Px10
AC/DC
GND
Px10
SLOPE
PUSH LONG
CAL
2Vp-p
ILLUM
FOCUS
TRACE
ROTATION
INTEN
TRACE/
READOUT
POWER
OFF
CH1
CH2
EXT

Triggering

Trigger controls



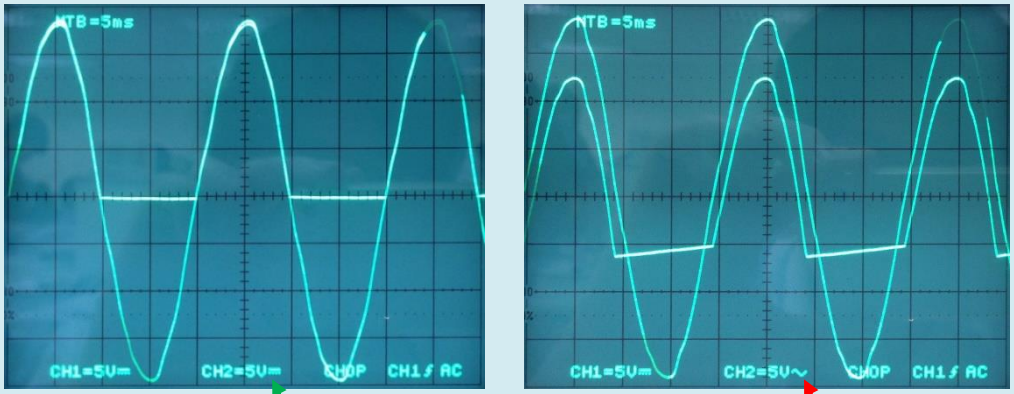




Oscilloscope: DC vs. AC Modes

- Input signal: $v(t)$
- DC mode: Show $v_{DC}(t) = v(t)$
- AC mode: Show $v_{AC}(t) = v(t) - \mathrm{V_{DC}}$
  - $v_{AC}(t)$ always have 0 average (theoretically)
- $v_{AC}(t) = v_{DC}(t)$ when $\mathrm{V_{DC}} = 0$.

Ex. Lab 6

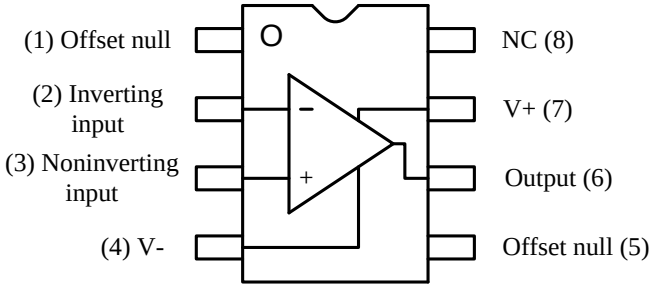


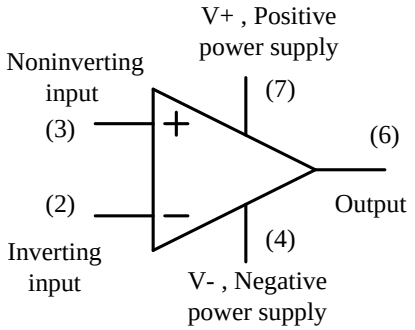
Correct

Wrong

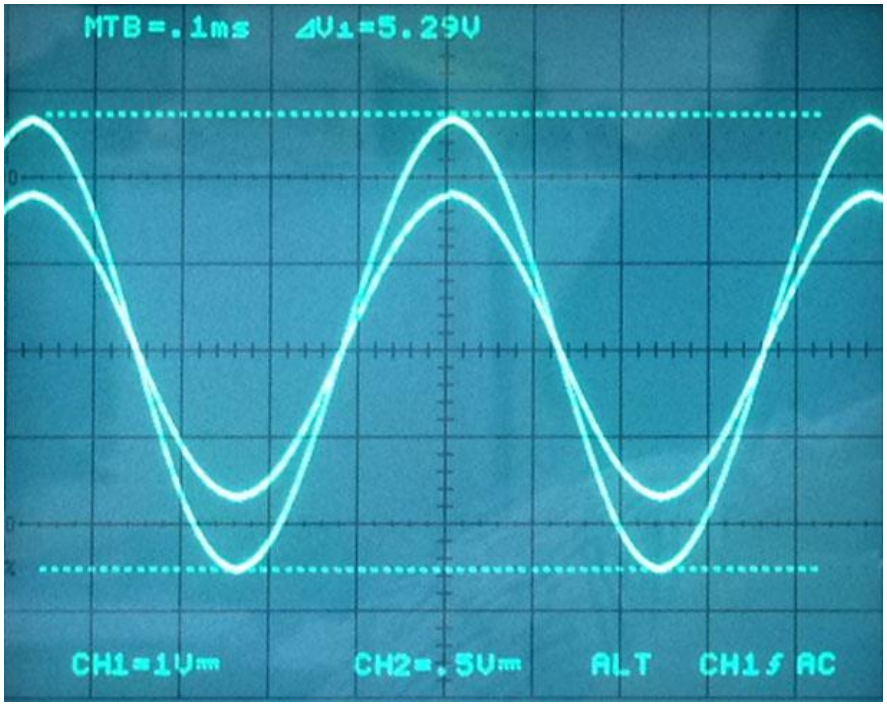
Tips

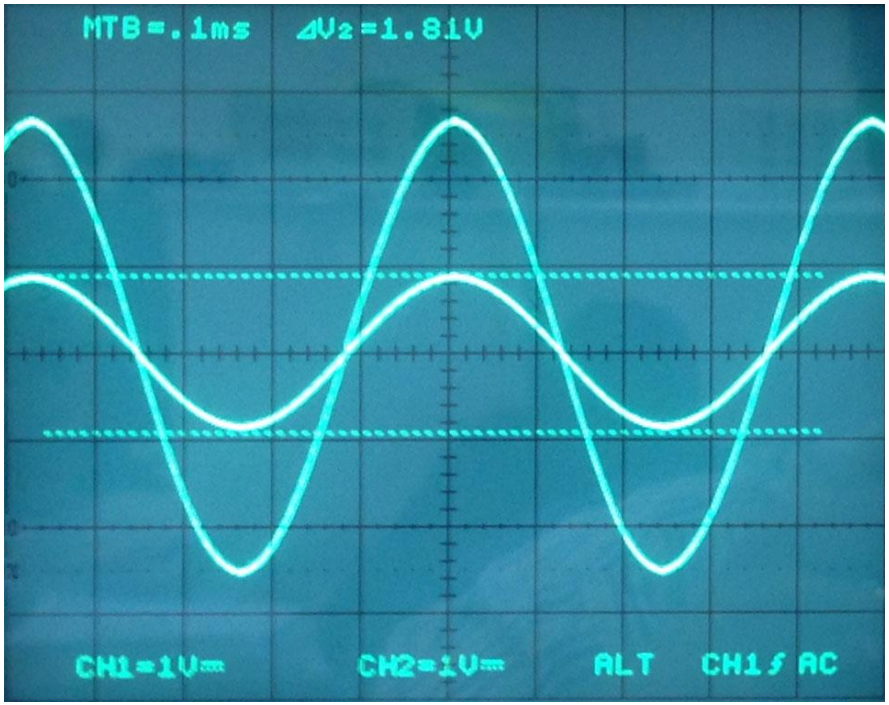
- Know the difference between the DC and AC modes of the **DMM**
- Know the difference between the DC and AC modes of the **oscilloscopes.**
- Know how to subtract signals inside the oscilloscope.
- For peak-to-peak measurement, learn how to use cursor measurement on the oscilloscope instead of counting divisions.
- Don't forget about the 50Ω *inside* the **function generator**.
  - Open-circuit voltage.
- The op-amp pins info will be provided.



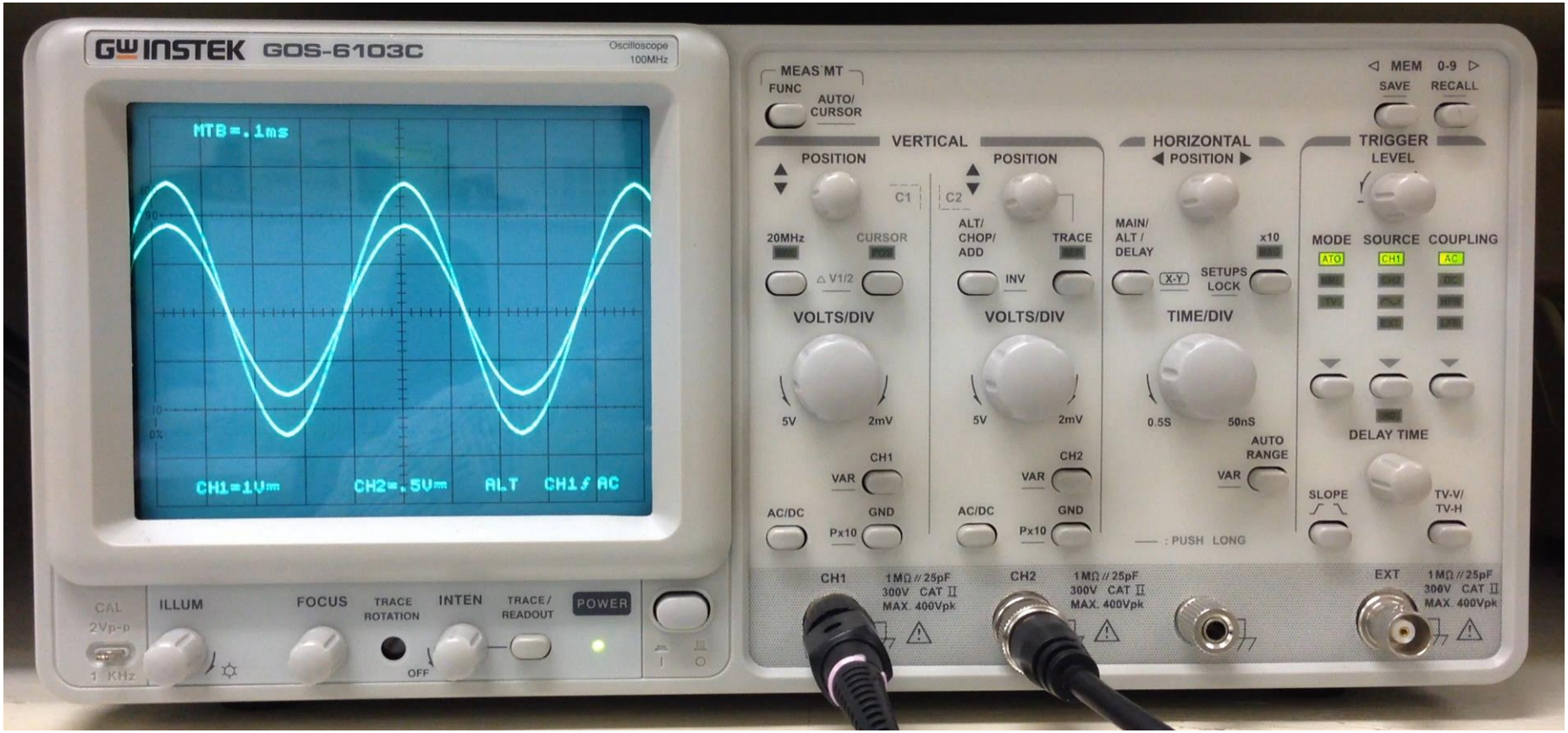


Peak-to-peak reading from the scope

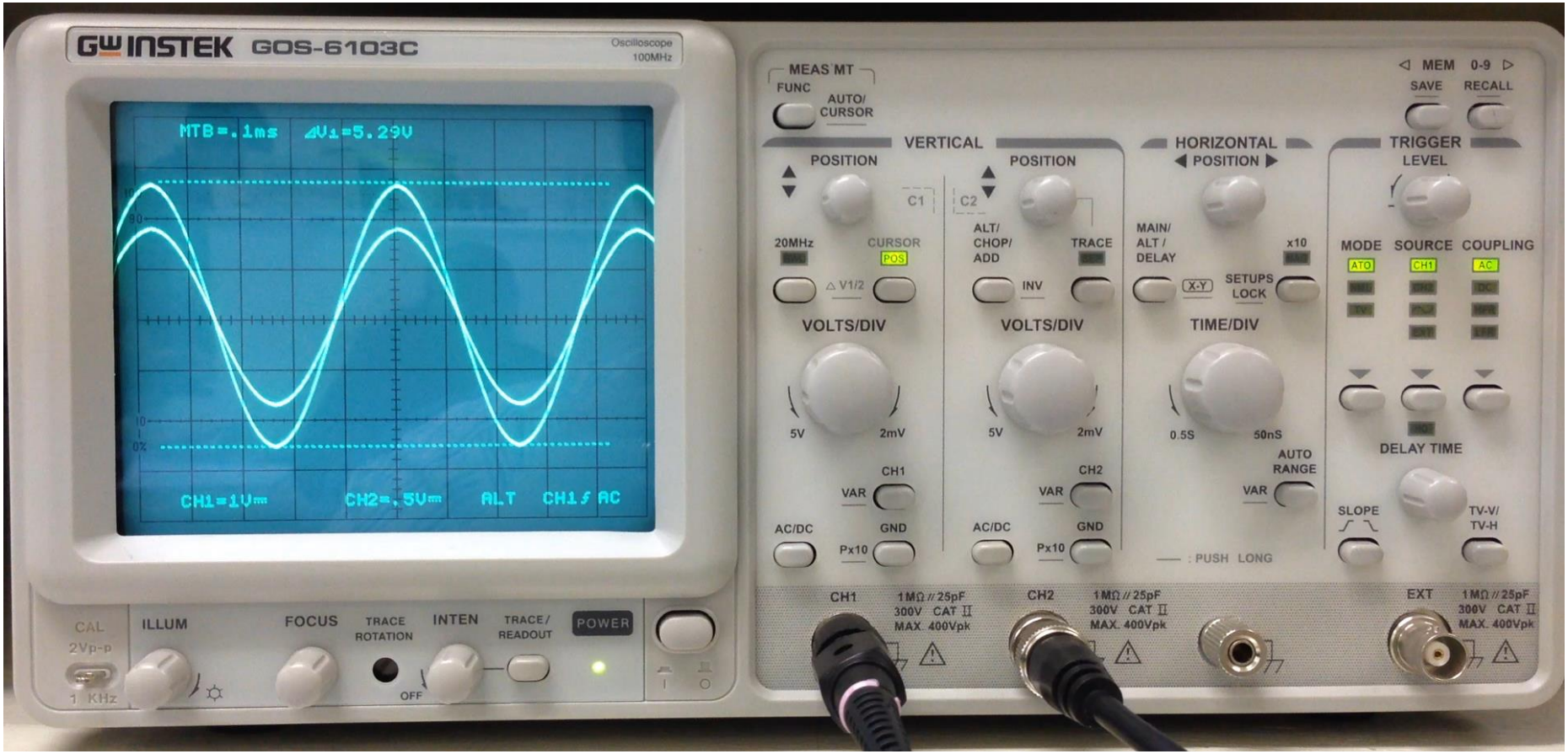




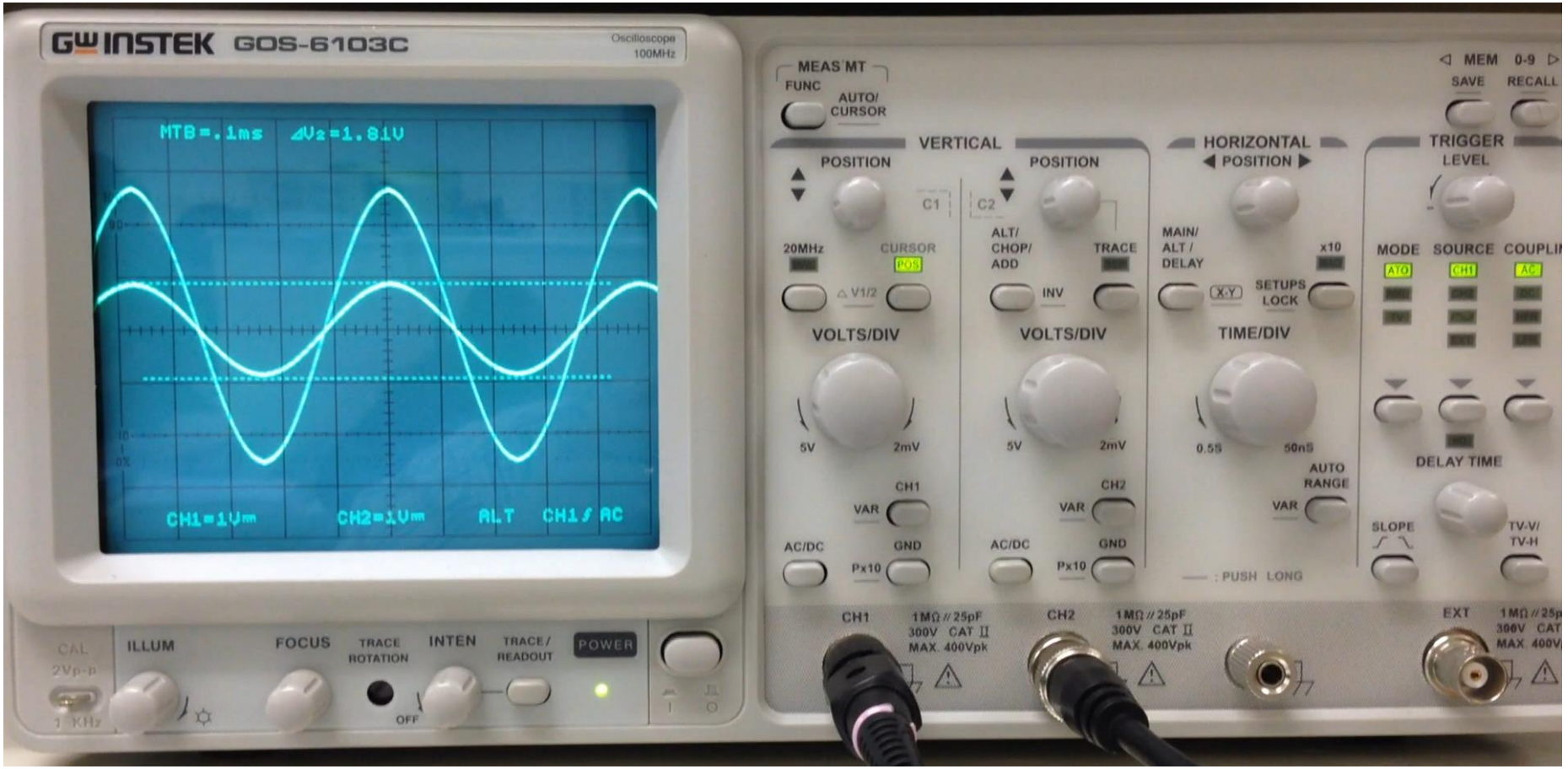
Peak-to-peak reading from the scope (1/3)



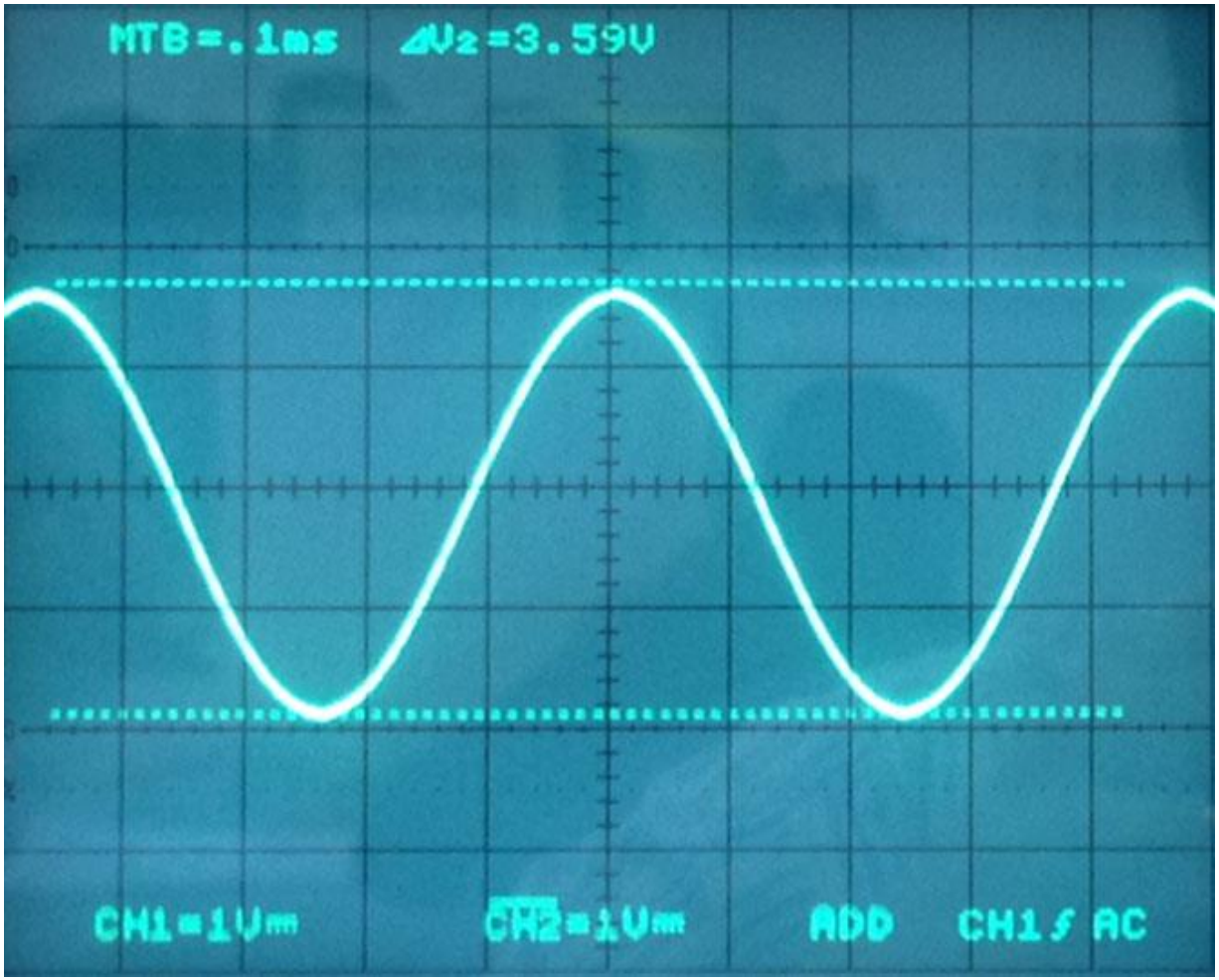
Peak-to-peak reading from the scope (2/3)



Peak-to-peak reading from the scope (3/3)

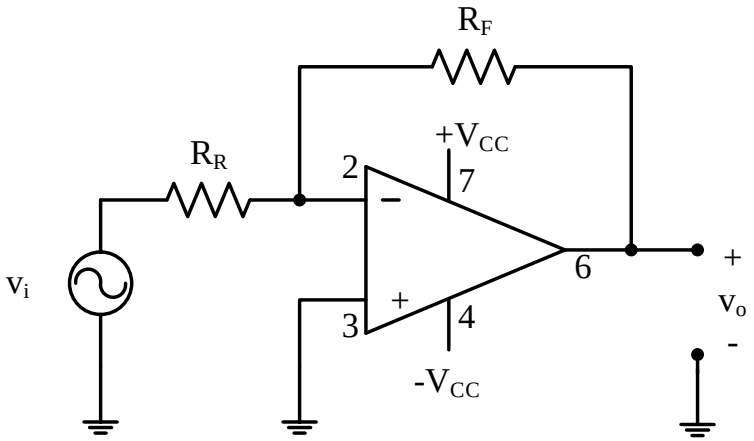


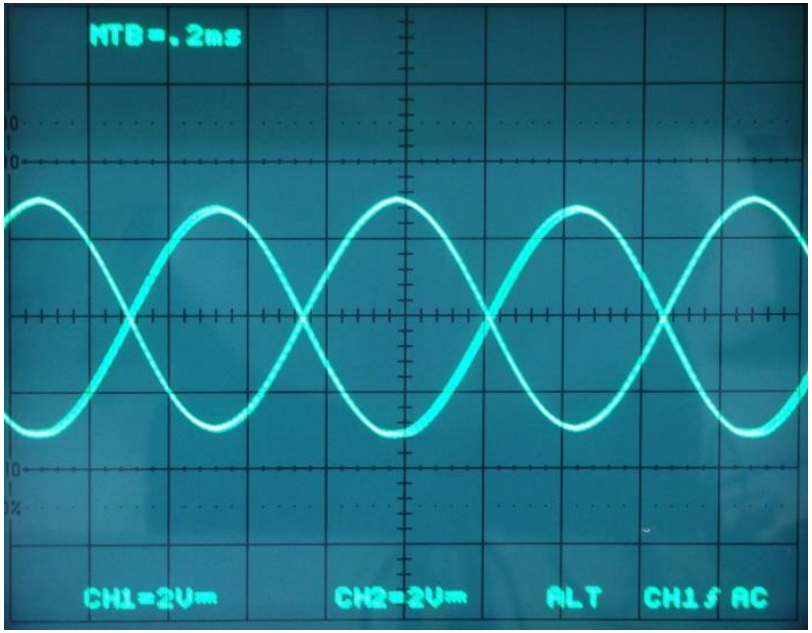
Peak-to-peak reading from the scope



New Type of Problems

- Problem 3 (part a)





Correction

- Problem 3 (part **b**)