

EE-241. Introductory Electronics Laboratory

Handout #4.*

Fall 2009

Recommended Reading

Appendix D. Computer-Aided Circuit Analysis, *Electrical Engineering* by Hambley.

Exercise Due Date

Week of Sept 28th.

Exercise Problems

In this set of exercises, you will learn to understand and visualize parametric curves in $2D$. You will then learn how to employ this mathematical skill in a practical electrical measurement scenario. You may use MATLAB to help with sketching these curves. However, it is strongly recommended to solve these exercises without the use of a computer.

1. A curve in the plane is described by points that can be given coordinates $(x(t), y(t))$, where t is the independent parameter of the curve and x, y are its components along the two axes. An example is a parabola described by $x(t) = t$ and $y(t) = t^2$. Sketch a parametric curve given by $(\cos(t), \sin(t))$. You may vary t between 0 and 2π .
2. Now sketch several curves of $(\sin(t), \sin(t + \phi))$ by fixing the angle for each sketch at ϕ at $0, \pi/3, \pi/2, \pi$.
3. Next try $(\sin(t), \sin(kt))$, by trying values of $k = 1, 2, 3, 4$.

Let us get back to circuits and electrical measurements. You have been using *digital* oscilloscopes in your lab. In older *analog* oscilloscopes, what you see on the screen is the florescence produced by an electron beam in a Cathode Ray tube (CRT) deflected by two sets of plates. One set is called the X plate and the other the Y plate. The amount of voltage on each set of plates deflects the beam in the X or Y direction. Due to the persistence of vision, this creates a pattern on the screen (CRT-based TV screens work on the same principle). See Figure 1 for elaboration on this.

But this is exactly like tracing a parametric curve in the plane. To display a time-varying voltage on the screen the following voltages are applied to the plates. The voltage to be measured

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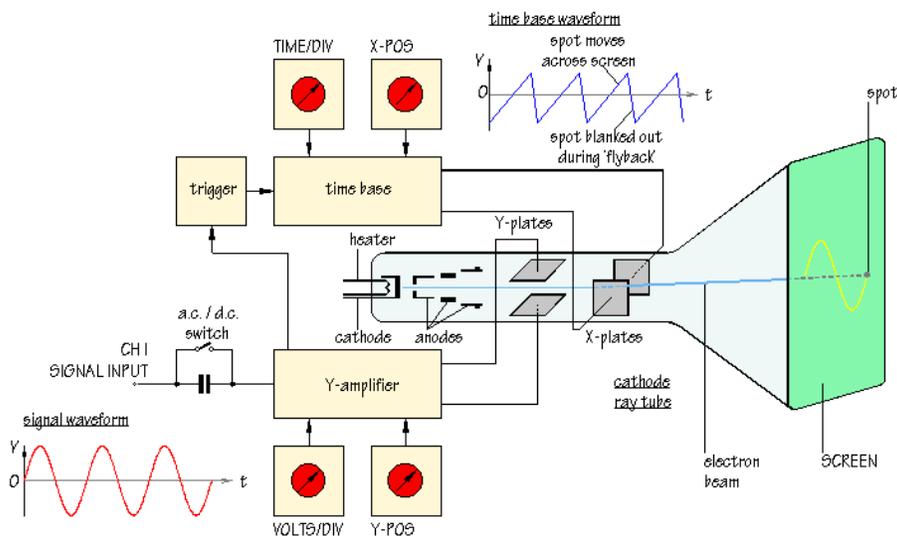


Figure 1: CRT Oscilloscope. Courtesy: <http://www.doctrionics.co.uk/scope.htm>

V is applied to the Y plate. To generate a linear progression of time, a periodic *ramp* signal is generated internally in the instrument. The ramp is brought back to its initial value to cater to a limited screen size. This creates the illusion of plotting a *graph* of the voltage on the screen. Recall, how you draw a graph of a function, say f . Each point of this graph can be represented by a pair $(t, f(t))$. Therefore, you can also think of this graph as a curve in $2D$, in which each point is *parameterized* by an independent variable t .

1. Predict what will you see on the CRT when the voltages applied to X and Y plates are driven by two function generators, one of which is set at a sinusoidal frequency of 1KHz, 1V (peak to peak); and the second to 1KHz, sinusoidal, 1V (peak to peak). Remember that we have no control over the phase angle of the two voltage sources. Explain the different outcomes that are possible on the screen. Now try 2KHz on Y . What you see on the screen are called Lissajous patterns.
2. Consider the setup in Figure 2, where the oscilloscope is the same as that in the lab. If you push **Format** \rightarrow **XY** on your instrument, you can use the two channels to produce $(CH1(t), CH2(t))$ on the screen. (Try it, some day in your lab.)
Now, refer to step 12 of your first experiment on OP-AMPS (Page 40, Tsividis). What will you see on your screen if you set $V_{REF} = 0$, CH1 to v_{SIG} and CH2 to v_{OUT} ? Does this look familiar to anything you have already explored in this lab experiment?

Some Fun with an Oscilloscope

<http://www.youtube.com/watch?v=s1eNjUgaB-g&feature=related>

Think how this would have been possible.

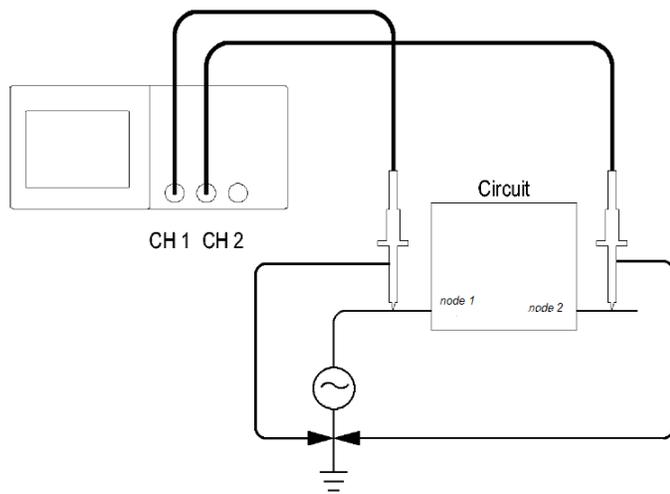


Figure 2: Using the *XY* feature in an oscilloscope.