

# Graphing/Drawing Tools for Physics Research

Especially, TikZ.

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## Graphing - popular tools

- ▶ What software do you use for plotting? (Multi-select)
  - ▶ Mathematica (54)
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  - ▶ **GeoGebra** (30)
  - ▶ MS Excel (23)
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  - ▶ **ggplot** (2)
  - ▶ LabView (2)
  - ▶ etc...

<http://bit.ly/2wdEGfC>, Bold face: free software.

# Drawing - popular tools

- ▶ MS PowerPoint
- ▶ Adobe Illustrator
- ▶ HancomOffice Hanword
- ▶ **GeoGebra**
- ▶ **TikZ**
- ▶ **Inkscape** / **GIMP** / mspaint
- ▶ draw by hand

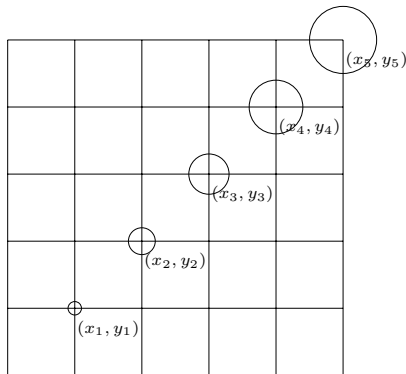
Bold face: free software.

# TikZ

- ▶ `\draw (0,0) -- (1,1);`
- ▶ `\draw (0,0) rectangle (1,1);`
- ▶ `\draw (0,0) circle [radius=0.5];`
- ▶ `\node at (0,0) {Some text};`
- ▶ `\draw plot (\x, {\sin(\x)});`

## for loop in TikZ

```
\draw (0,0) grid (5,5);  
\foreach \i in {1,2,...,5}{  
  \draw (\i,\i) circle [radius=0.1*\i];  
  \node at (\i+0.5, \i-0.3)  
  {\scriptsize $ (x_{\i},y_{\i}) $};  
}
```



# Drawing animation with TikZ

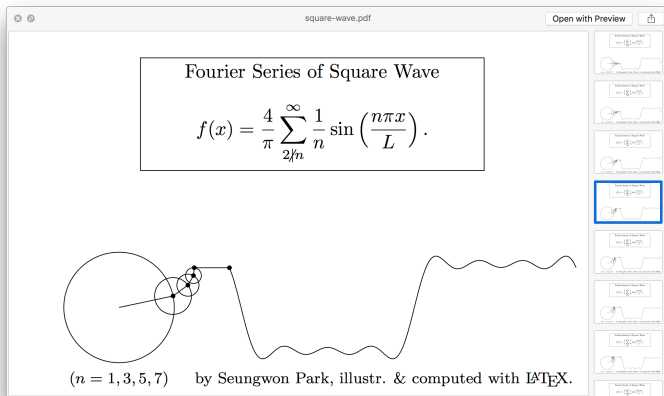
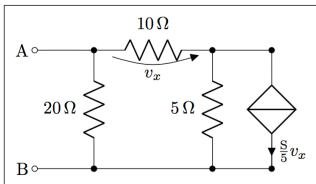


Image: [i.imgur.com/l3GFf15.gif](https://i.imgur.com/l3GFf15.gif) / Source: [git.io/vHrAL](https://git.io/vHrAL)

# circuitikz

- ▶ circuitikz package for circuit drawing
- ▶ No more annoying mouse-clicking!
- ▶ > `texdoc circuitikz`

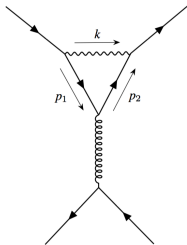


```
1 \begin{circuitikz}[scale=1.2]\draw
2   (0,0) node[anchor=east] {B}
3     to[short, o-*] (1,0)
4     to[R=20<\ohm>, **] (1,2)
5     to[R=10<\ohm>, v=$v_x$] (3,2) -- (4,2)
6     to[cI=$\frac{\siemens}{5} v_x$, **] (4,0) -- (3,0)
7     to[R=5<\ohm>, **] (3,2)
8   (3,0) -- (1,0)
9   (1,2) to[short, -o] (0,2) node[anchor=east]{A}
10;\end{circuitikz}
```



# tikz-feynman

- ▶ Drawing Feynman diagrams with TikZ
- ▶ `> texdoc tikz-feynman`



```
\feynmandiagram [large, vertical=e to f] {  
  a -- [fermion] b -- [photon, momentum=\(k\)] c -- [fermion] d,  
  b -- [fermion, momentum'=\(p_{1}\)] e -- [fermion, momentum'=\(p_{2}\)] c,  
  e -- [gluon] f,  
  h -- [fermion] f -- [fermion] i;  
};
```

- File - Export - Graphics View as PGF/TikZ
- If you don't need a vector graphic, just do a screenshot!

The screenshot shows the GeoGebra interface with a triangle and its properties. The Algebra View on the left lists the objects: Point A (1.56, 4.16), Point B (0.42, -0.24), Point C (4.62, 1.96), Segment a = 4.74, Segment b = 3.77, Segment c = 4.55, and Triangle poly1 = 7.99. The Graphics View shows the triangle with vertices A, B, and C, and sides a, b, and c. The right panel shows the 'GeoGebra to PGF Export' dialog with various settings for exporting the graphics view as PGF/TikZ code.

GeoGebra to PGF Export

X units (cm)	1.0	Picture width	21.2
Y units (cm)	1.0	Picture height	11.539999999999
x Min	-4.3	x Max	16.9
y Min	-5.2399999999999	y Max	6.2999999999999

Document font size: 10 pt    Format: LaTeX (article class)

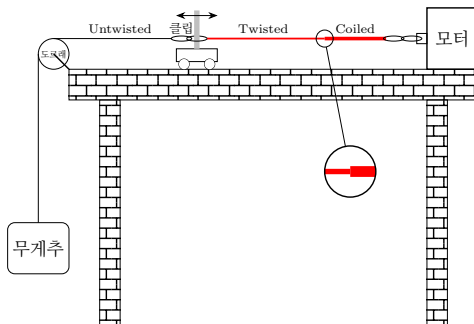
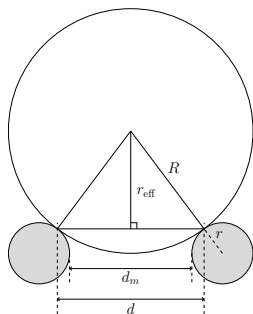
☐ Use Gnuplot to plot functions    ☒ Display the symbol for points

☐ Grayscale

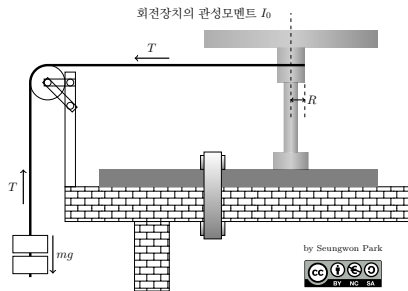
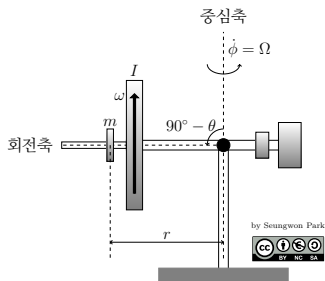
      

```
\documentclass[10pt]{article}
\usepackage{pgf,tikz}
\usepackage{mathrsfs}
\usetikzlibrary{arrows}
\pagestyle{empty}
\begin{document}
\definecolor{zzttqq}{rgb}{0.6,0.2,0.}
\definecolor{qqqqff}{rgb}{0.,0.,1.}
\begin{tikzpicture}[line cap=round,line join=round,>=triangle 45,x=1.0cm,y=1.0cm]
\clip(-4.3,-5.24) rectangle (16.9,6.3);
\fill[line width=1.2pt,color=zzttqq,fill=zzttqq,fill opacity=0.10000000149011612]
\draw [line width=1.2pt,color=zzttqq] (1.56,4.16) -- (0.42,-0.24);
```

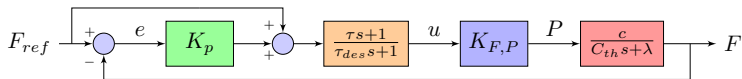
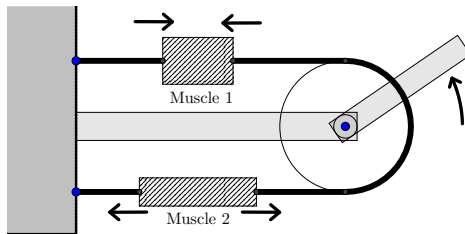
- Some simple examples.



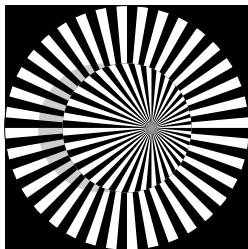
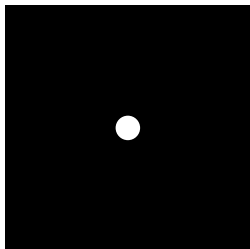
- Some examples: From my physics lab. course report



- Some examples: From my high-school R&E



- Some examples: My profile pictures



## Some tips on using TikZ

- ▶ Use `standalone` class and make single image file.
  - ▶ Helpful for reducing compilation time
- ▶ If compiling time  $\rightarrow \infty$ , perhaps you've missed semicolon ;.
- ▶ For various usage, have a look at `texample.net`.

# Pros/Cons of using TikZ




- ▶ Pros:
  - ▶ Free.
  - ▶ Good for drawing simple(but important) figures.
  - ▶ Enables repetitive job.
  - ▶ Lots of science-related packages.
  - ▶ Again, no mouse-clicking required.
- ▶ Cons:
  - ▶ Quite annoying to set coordinates.
  - ▶ ... plus, common weak points of WYSIWYM.



# Conclusion

- ▶ 'Standard' graphing tool: Excel, matplotlib, R, ...
  - ▶ R also helps plot reverse-engineering(?).
- ▶ TikZ is the best drawing tool among free software.
  - ▶ Try using TikZ for drawing figures.
- ▶ 표현 수단의 확대 → 표현의 확대 → 생각의 확대
  - ▶ *Cited from [3].*

# References

-  TikZ& PGF Manual for Version 3.0.1a
-  Joshua Ellis. 'TikZ-Feynman: Feynman diagrams with TikZ'.  
arXiv: 1601.05437 [hep-ph]
-  윤석천 (2015)  $\text{\LaTeX}$  쉽게 쓰기 : <http://bit.ly/2tXsRgi>