

Engineering Department Professionalism: Graphing Standard

Introduction - A big part of an engineer's job is to communicate. This often involves presenting experimental or theoretical results in graphical format. Your audience may include other engineers with-in or outside your company, management within your company, marketing personnel, or potential customers. The strategy that you use as you design your graphs may differ depending on audience, but there are some general standards that will help you to efficiently and clearly convey information. The ability to create a good graph is extremely important for the success of an engineer, and it is worth the extra time to make your graphs sparkle.

While you are taking engineering classes at Walla Walla University, your professors will have varying expectations of what a good graph should look like. This also varies depending on the purpose of the graph. However, the following list of design rules apply to nearly all of the graphs you will produce as a student. Take time to familiarize yourself with this list and apply these guidelines as you create graphs for your classes. Take note that, in general, the default values provided in graphing software are wrong and will require adjustment. These guidelines will maximize your opportunity to get good grades on your assignment and give you good practice for any graphs you create in your future careers.

Essential Graph Components

1. Title - The graph title needs to be descriptive. With the appropriate title, the graph should stand alone. A graph title at the top is not needed when a descriptive caption is used with a figure number at the bottom of the graph.
2. Origin - Do not exclude the origin of coordinates $(0, 0)$ from the graph unless there is a *good* reason to do so.
3. Scales - Use sensible numbers (multiples of $1, 2, 5 \times 10^n$, where n is an integer) and spacings for axis scales. Construct the graph to clearly depict that the scales are linear, semi-log, or log-log.
4. Legends - Provide a legend describing *each* curve or data set on the graph when there is more than one.
5. Graph Axes and Units - Provide labels for axes and units (when appropriate). The dependent variable should be on the vertical axis.
6. Curve Fitting - Only provide curve fit to data *when directed to do so* or when your data set is used to generate a curve (with curve fit equation shown).
7. Data Points - Experimental data points need to be clearly described in the legend and need to be *points* of data on the graph (not lines, nor connected by lines). Use unique symbols for each data set.
8. Tick Marks - Use limited number of tick marks as axis scale divisions and numbers only on some tick marks.
9. Landscape or Portrait Graphs - In a bound document the top of graph should be at the top or left.

Examples

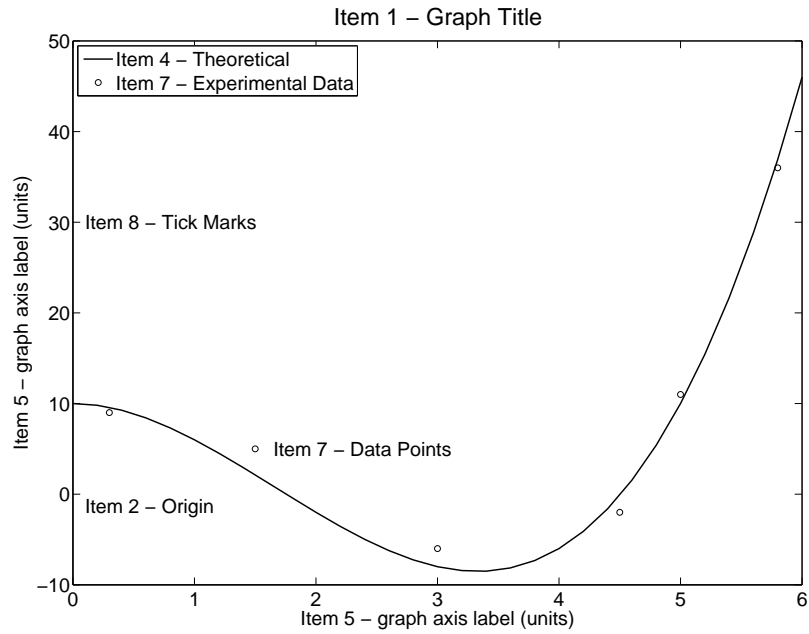


Figure 1: Example with essential graph components identified.

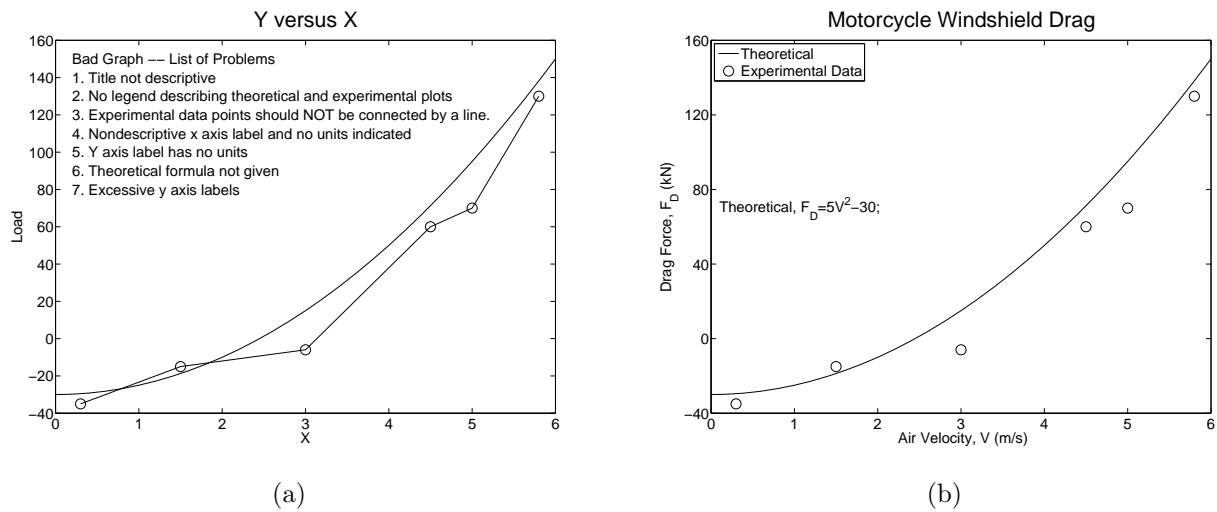


Figure 2: Examples: (a) Bad graph, (b) Good graph.

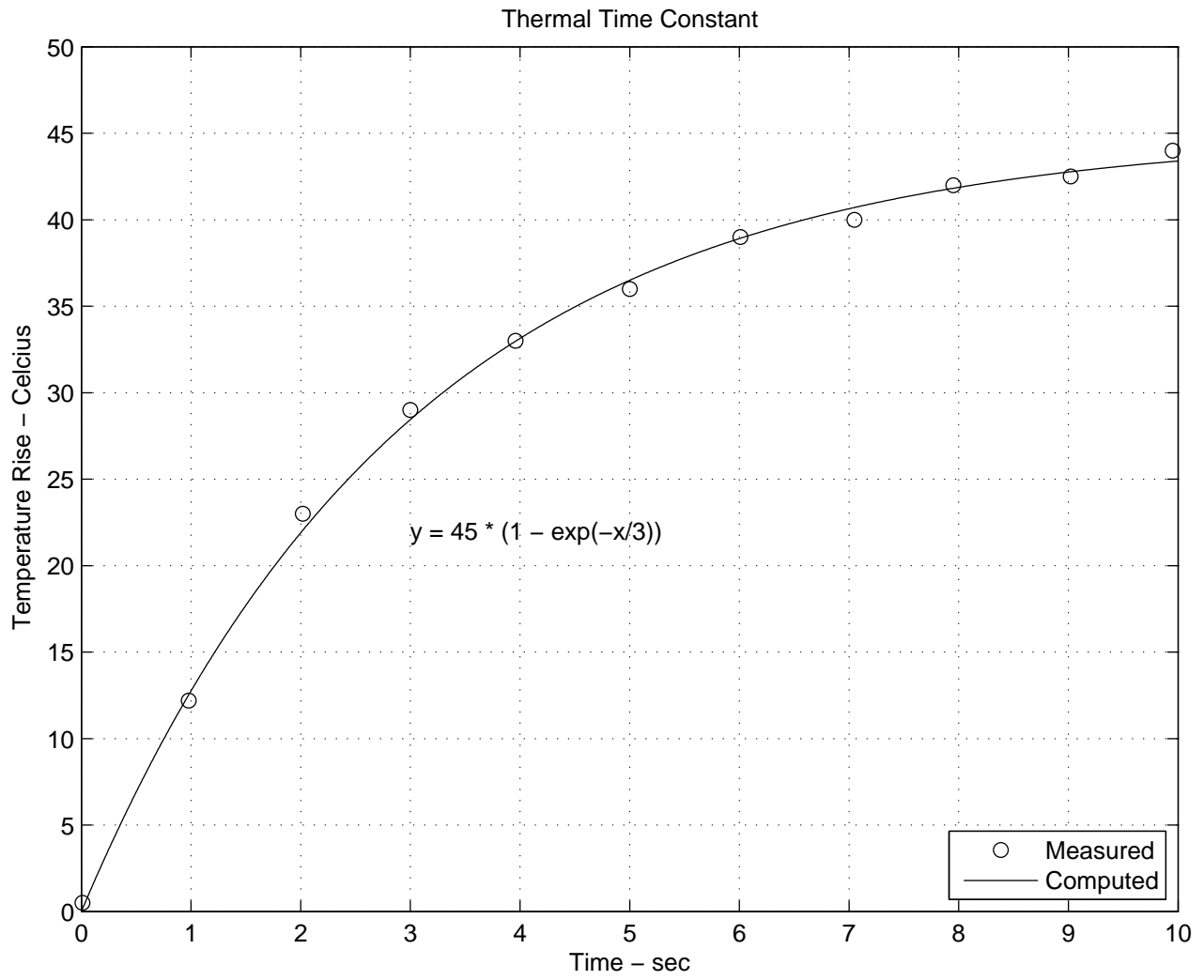


Figure 3: Example graph.

APPENDIX - Example Scripts

Matlab script for essential graph components, Figure 1.

```
%terms.m
%Script to plot a graph with terms identified on the plot

%Function curve
x=(0:0.2:6)';
y=x.^3-5*x.^2+10;

%data points
xr=[0.3;1.5;3;4.5;5;5.8];
yr=[9;5;-6;-2;11;36];
fsize=20;

plot(x,y,'k','linewidth',1.5);
hold on
plot(xr,yr,'ko')
%add title and axis labels
title('Item 1 - Graph Title','fontsize',fsize+4)
xlabel('Item 5 - graph axis label (units)','fontsize',fsize)
ylabel('Item 5 - graph axis label (units)','fontsize',fsize)
text(0.1,-1.3,'Item 2 - Origin','fontsize',fsize)
h1=legend('Item 4 - Theoretical','Item 7 - Experimental Data',2);
set(h1,'fontsize',fsize)
text(xr(2)+0.15,yr(2),'Item 7 - Data Points','fontsize',fsize)
text(0.1,30,'Item 8 - Tick Marks','fontsize',fsize)
%set axis numbers fontsize
set(gca,'fontsize',fsize)
```

Matlab script for Figure 2a.

```
%bad.m bad graph example
%Script to plot a graph with terms identified on the plot

%Function curve
x=(0:0.2:6)';
y=5*x.^2-30;

%data points
xr=[0.3;1.5;3;4.5;5;5.8];
yr=[-35;-15;-6;60;70;130];
fsize=22;

plot(x,y,'k','linewidth',1.5);
hold on
plot(xr,yr,'ko-','markersize',15)
%grid on
title('Y versus X','fontsize',fsize+10)
xlabel('X','fontsize',fsize)
```

```

ylabel('Load','fontsize',fsize)
%text(0.1,-1.3,'Item 2 - Origin','fontsize',fsize)
%h1=legend('Item 4 - Exact Curve','Item 7 - Experimental Data',2);
%set(h1,'fontsize',fsize)
%text(xr(2)+0.15,yr(2),'Item 7 - Data Points','fontsize',fsize)
%text(0.1,30,'Item 8 - Tick Marks','fontsize',fsize)
%set axis numbers fontsize
set(gca,'fontsize',fsize)
nlist=8;
ypinc=10;
xp=zeros(nlist,1);
yp=zeros(nlist,1);
for i=1:nlist;
    xp(i)=0.2;
    yp(i)=150-(i-1)*ypinc;
end;
problast={'Bad Graph -- List of Problems';...
    '1. Title not descriptive';...
    '2. No legend describing theoretical and experimental plots';...
    '3. Experimental data points should NOT be connected by a line.';
    '4. Nondescriptive x axis label and no units indicated';
    '5. Y axis label has no units';...
    '6. Theoretical formula not given';...
    '7. Excessive y axis labels'};
text(xp,yp,problast,'fontsize',fsize)

```

Matlab script for Figure 2b.

```

%good.m good graph example
%Script to plot a graph with terms identified on the plot

%Function curve
x=(0:0.2:6)';
y=5*x.^2-30;

%data points
xr=[0.3;1.5;3;4.5;5;5.8];
yr=[-35;-15;-6;60;70;130];
fsize=22;

plot(x,y,'k','linewidth',1.5);
hold on
plot(xr,yr,'ko','markersize',15)
%grid on
title('Motorcycle Windshield Drag','fontsize',fsize+10)
xlabel('Air Velocity, V (m/s)','fontsize',fsize)
ylabel('Drag Force, F_D (kN)','fontsize',fsize)
%text(0.1,-1.3,'Item 2 - Origin','fontsize',fsize)
h1=legend('Theoretical','Experimental Data',2);
set(h1,'fontsize',fsize)
%text(xr(2)+0.15,yr(2),'Item 7 - Data Points','fontsize',fsize)

```

```

text(0.1,70,'Theoretical, F_D=5V^2-30;', 'fontsize',fsize)
%set axis numbers fontsize
set(gca,'fontsize',fsize)
%set yaxis tick mark and label locations
set(gca,'YTick',[-40 0 40 80 120 160])

```

Octave and Matlab Script for Figure 3.

```

% example plotting routines for Octave and Matlab
% Ralph Stirling 2013-02-06

xdata = [0.01, 0.98, 2.02, 3.0, 3.96, 5.0, 6.01, 7.05, 7.95, 9.02, 9.95];
ydata = [0.5, 12.2, 23., 29.,33., 36., 39., 40., 42., 42.5, 44.];

x = 0:.01:10;
y = 45 * (1 - exp(-x/3));

plot(xdata,ydata,'o',x,y,'r');

title('Thermal Time Constant');
axis([0 10 0 50]);
xlabel('Time - sec');
ylabel('Temperature Rise - Celcius');
grid on;
%The following legend command works in Matlab
legend('Measured','Computed',4)
%In octave the following commented "legend" commands would be used
%legend('Measured','Computed',"location","southeast");
%legend("boxon");
text(3,22,'y = 45 * (1 - exp(-x/3))');

print -deps example1.eps;

```