1. MATLAB 基本繪圖 (MATLAB Graphics)

```
x=[xi:dx:xf]          % xi 初值 (starting value);
                      % dx 增量值 (increment);
                      % xf 終值 (final value)
```

```
>>x=[0:0.1:1]'; y=x.*sin(x);
>>[x y]
ans =
0         0
0.1000    0.0100
0.2000    0.0397
0.3000    0.0887
0.4000    0.1558
0.5000    0.2397
0.6000    0.3388
0.7000    0.4510
0.8000    0.5739
0.9000    0.7050
1.0000    0.8415
```

Table A.4 Plot Formats

plot(x,y)	Plots the vector **x** versus the vector **y**.
semilogx(x,y)	Plots the vector **x** versus the vector **y**. The x-axis is $\log_{10}$; the y-axis is linear.
semilogy(x,y)	Plots the vector **x** versus the vector **y**. The x-axis is linear; the y-axis is $\log_{10}$.
loglog(x,y)	Plots the vector **x** versus the vector **y**. Creates a plot with $\log_{10}$ scales on both axes.

Table A.5 Functions for Customized Plots

title('text')	Puts 'text' at the top of the plot
legend (string1, string2, ...)	Puts a legend on current plot using specified strings as labels
xlabel('text')	Labels the x-axis with 'text'
ylabel('text')	Labels the y-axis with 'text'
text(p1,p2, 'text')	Adds 'text' to location (p1,p2), where (p1,p2) is in units from the current plot
subplot	Subdivides the graphics window
grid on	Adds grid lines to the current figure
grid off	Removes grid lines from the current figure
grid	Toggles the grid state

```
>>x=[0:0.1:1]';
>>y=x.*sin(x);
>>plot(x,y)
>>title('Plot of x sin(x) vs x ')
>>xlabel('x')
>>ylabel('y')
>>grid on
```

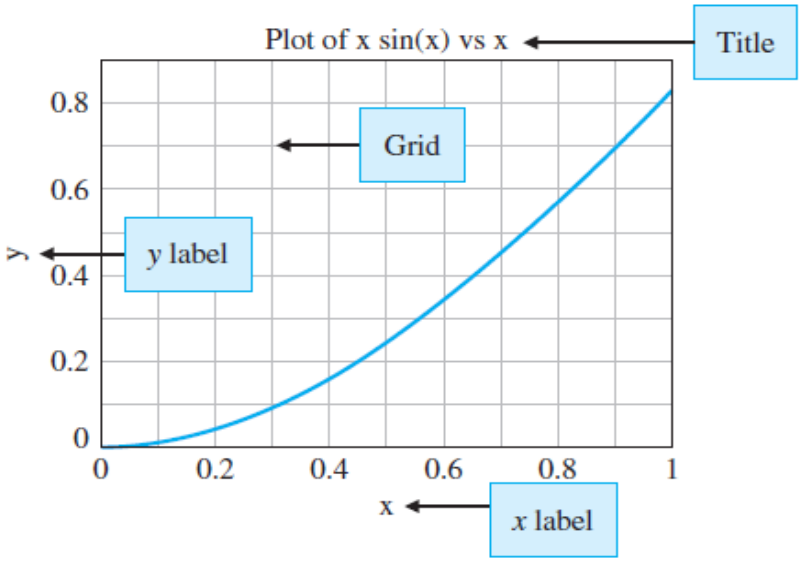
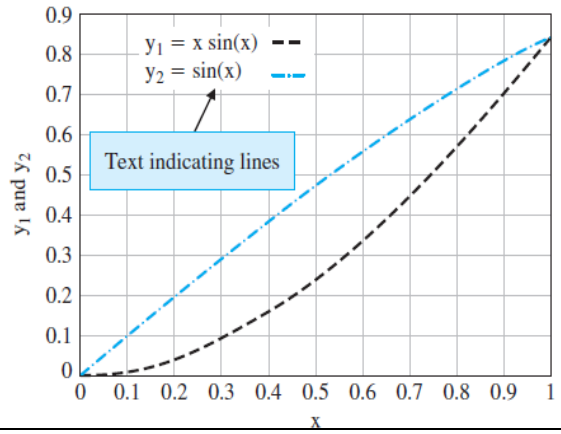


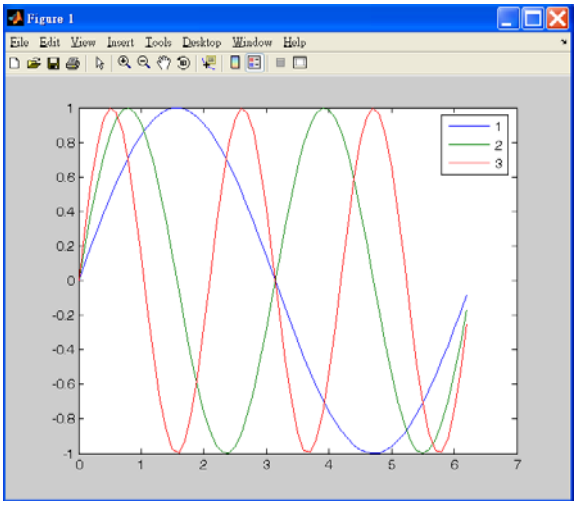
Table A.6 Commands for Line Types for Customized Plots

-	Solid line
- -	Dashed line
:	Dotted line
-.	Dashdot line

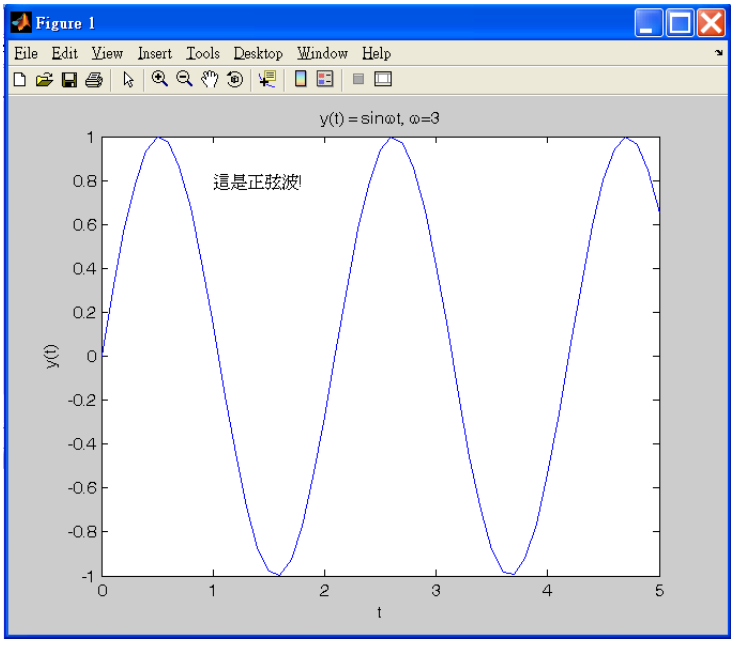
```
>> x=[0:0.1:1]';
>> y1=x.*sin(x); y2=sin(x);
>> plot(x,y1,'--',x,y2,'-.')
>> text(0.1,0.85,'y_1 = x sin(x) ---')
>> text(0.1,0.80,'y_2 = sin(x) .\_.\ _')
>> xlabel('x'), ylabel('y_1 and y_2'), grid on
```




```
>> t=0:0.1:2*pi;
>> plot(t,sin(t),t,sin(2*t),t,sin(3*t))
>> legend('1','2','3')
```



```
t=0:0.1:5;
plot(t,sin(3*t))
xlabel('t')
ylabel('y(t)')
title('y(t) = sin\omegat, \omega=3')
text(1,0.8,'這是正弦波!')
%axis([0 5 -2 2])
```



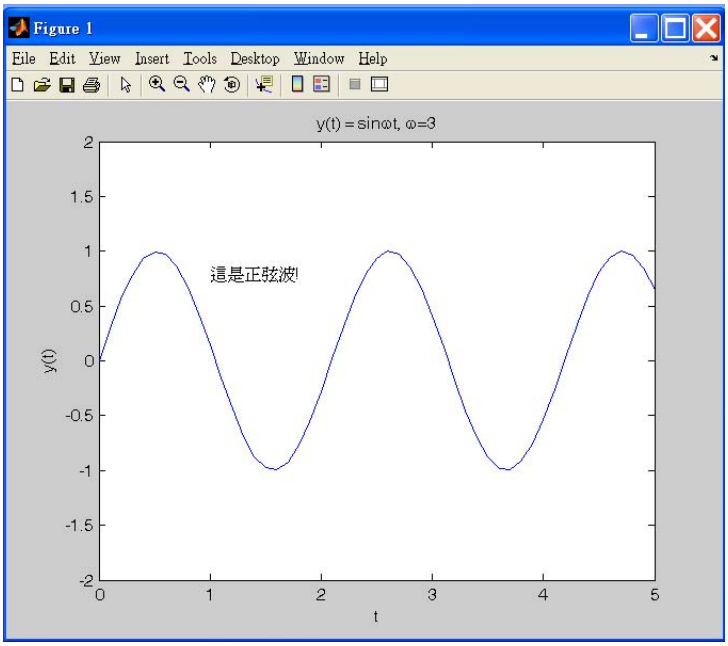
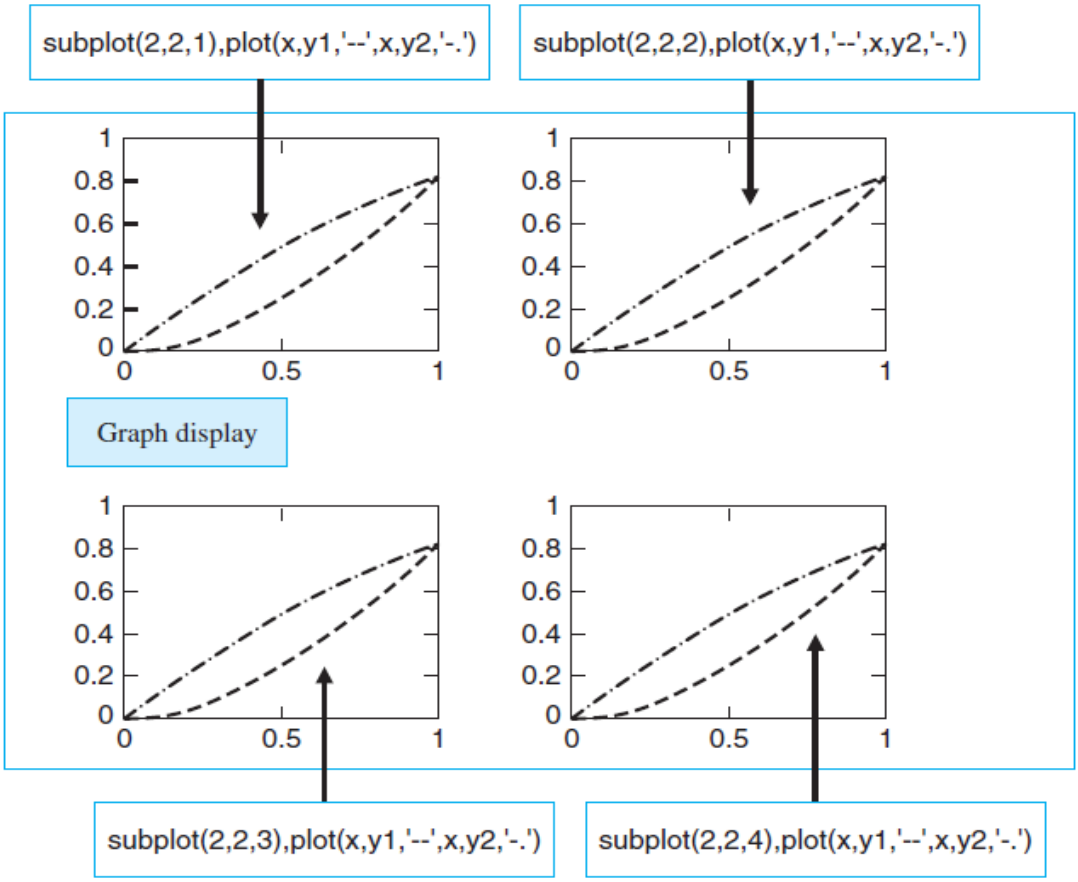
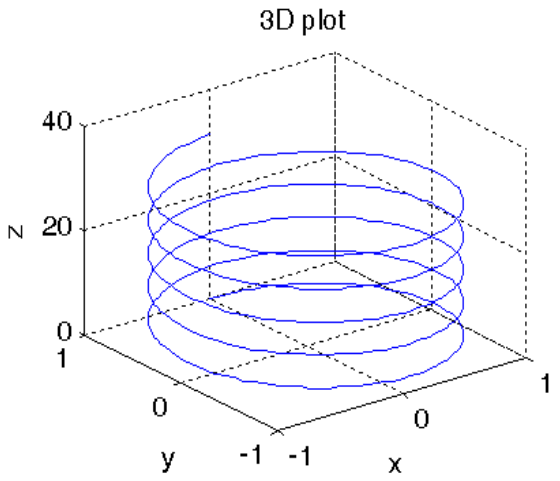


Table A.7 TeX Symbols and Mathematics Characters

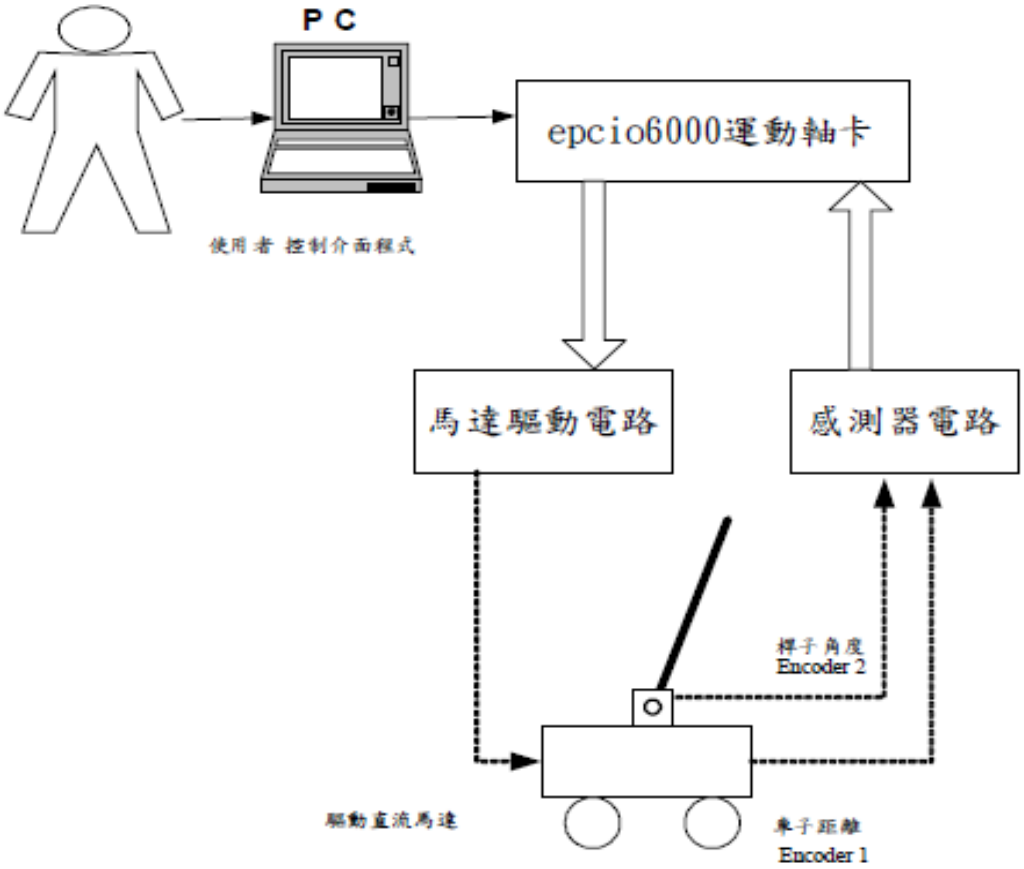
Character Sequence	Symbol	Character Sequence	Symbol	Character Sequence	Symbol
\alpha	α	\upsilon	υ	\sim	$\sim$
\beta	β	\phi	φ	\leq	$\leqslant$
\gamma	γ	\chi	χ	\infty	∞
\delta	δ	\psi	ψ	\clubsuit	$\clubsuit$
\epsilon	ϵ	\omega	ω	\diamondsuit	$\diamondsuit$
\zeta	ζ	\Gamma	Γ	\heartsuit	$\heartsuit$
\eta	η	\Delta	Δ	\spadesuit	$\spadesuit$
\theta	θ	\Theta	Θ	\leftrightarrow	$\leftrightarrow$
\vartheta	ϑ	\Lambda	Λ	\leftarrow	$\leftarrow$
\iota	ι	\Xi	Θ	\uparrow	$\uparrow$
\kappa	κ	\Pi	Π	\rightarrow	$\rightarrow$
\lambda	λ	\Sigma	Σ	\downarrow	$\downarrow$
\mu	μ	\Upsilon	Υ	\circ	$\circ$
\nu	ν	\Phi	Φ	\pm	$\pm$
\xi	ξ	\Psi	Ψ	\geq	$\geqslant$
\pi	π	\Omega	Ω	\propto	$\propto$
\rho	ρ	\forall	$\forall$	\partial	∂
\sigma	σ	\exist	$\exists$	\bullet	$\cdot$
\varsigma	ς	\ni	$\ni$	\div	$\div$
\tau	τ	\cong	$\cong$	\neq	$\neq$
\equiv	$\equiv$	\approx	$\approx$	\aleph	$\aleph$
\Im	$\Im$	\Re	$\Re$	\wp	$\wp$
\otimes	$\otimes$	\oplus	$\oplus$	\oslash	$\oslash$
\cap	$\cap$	\cup	$\cup$	\supseteq	$\supseteq$
\supset	$\supset$	\subseteq	$\subseteq$	\subset	$\subset$
\int	$\int$	\in	$\in$	\o	o

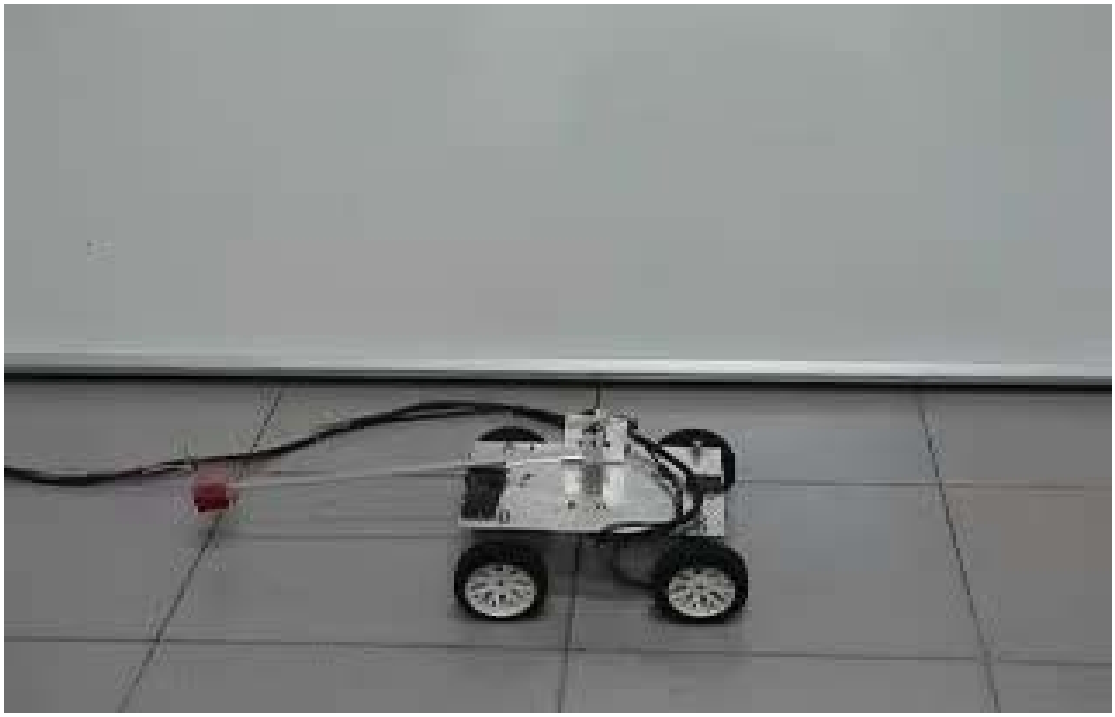


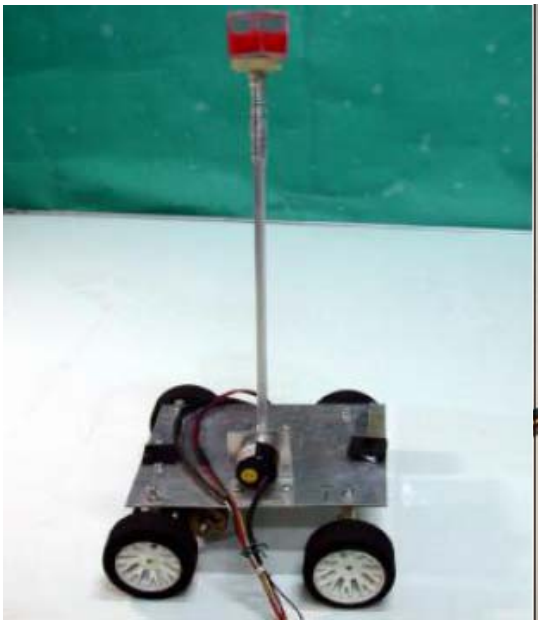

```
t=0:pi/50:10*pi;
plot3(sin(t),cos(t),t);                    % Also check comet3
grid;
xlabel('x');
ylabel('y');
zlabel('z');
title('3D plot');
```



倒單擺(Inverted Pendulum)平衡實驗







光學編碼器

驅動器

IP Modeling

For pendulum,

$$J\ddot{\theta} = F_y l \sin\theta - F_x l \cos\theta$$

where

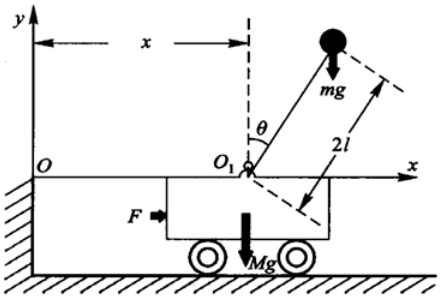
$$F_x = m\frac{d^2}{dt^2}(x + l\sin\theta)$$

and

$$F_y - mg = m\frac{d^2}{dt^2}(l\cos\theta)$$

For cart,

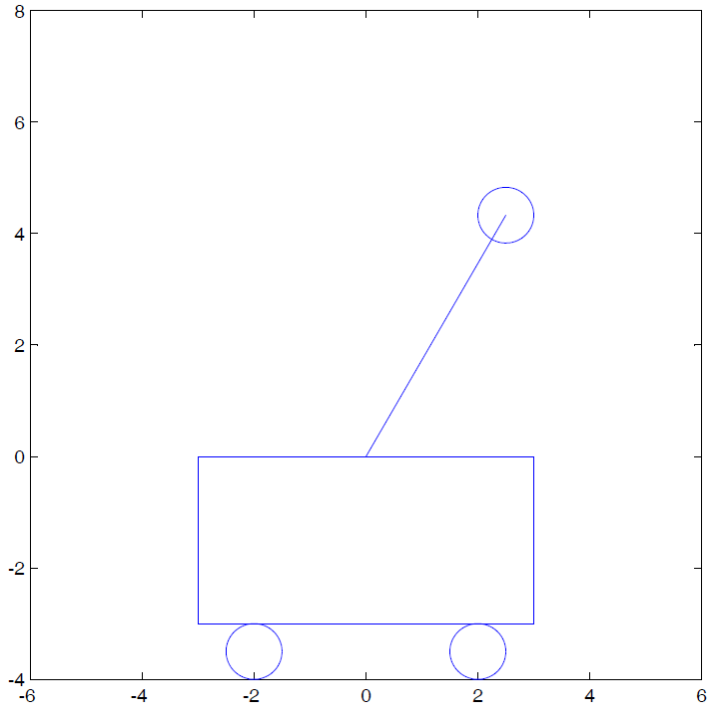
$$F - F_x = M\frac{d^2x}{dt^2}$$



$$(J + ml^2)\ddot{\theta} + ml\cos\theta \cdot \ddot{x} = mlg\sin\theta$$

$$(M + m)\ddot{x} + ml(\cos\theta \cdot \ddot{\theta} - \sin\theta \cdot \dot{\theta}^2) = F$$

Exercise: (Draw an IP moving platform)



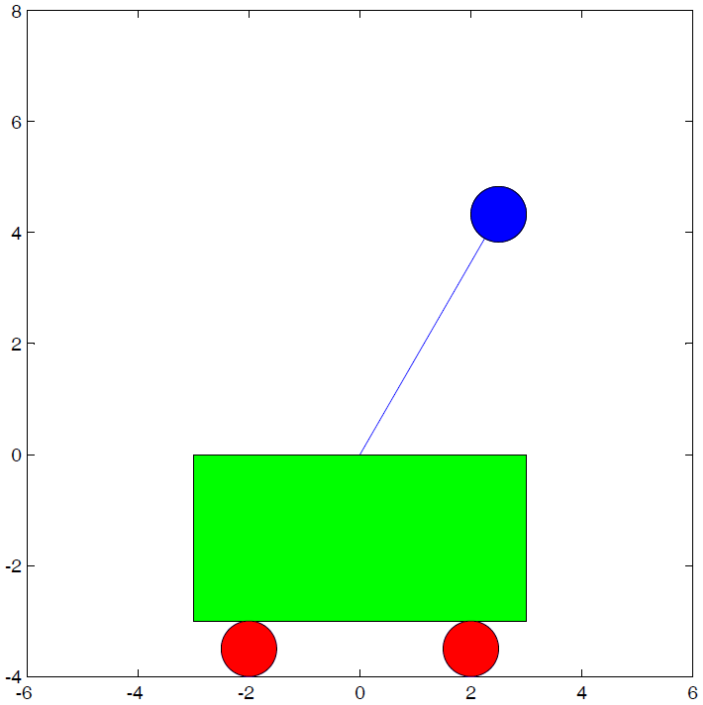
畫一倒單擺移動平台

```
>> xp=[0 5*sin(pi/6)];                    % 桿子
>> yp=[0 5*cos(pi/6)];
>> plot(xp,yp)
>> axis([-6 6 -4 8])
>> hold on

>> the=0:0.01:2*pi;                       % 桿子頂端球
>> x=5*sin(pi/6)+0.5*cos(the);
>> y=5*cos(pi/6)+0.5*sin(the);
>> plot(x,y)

>> xb=[-3 3 3 -3 -3];                     % 車身方塊
>> yb=[-3 -3 0 0 -3];
>> plot(xb,yb)

>> plot(2+0.5*cos(the),-3.5+0.5*sin(the))    % 右輪
>> plot(-2+0.5*cos(the),-3.5+0.5*sin(the))   % 左輪
>> axis('square')                            % 兩軸單位等長
```



充填顏色

```
fill                                % color can be 'r','g','b','c','m','y','w', or 'k'
                                    % or an RGB row vector triple, [r g b],
>> fill(x,y,'b')
>> fill(xb,yb,'g')
>> fill(-2+0.5*cos(the),-3.5+0.5*sin(the),'r')
>> fill(2+0.5*cos(the),-3.5+0.5*sin(the),[1 0 0])
```