Campana di Pompelmo

⊞— dsol

⊟

// INPUT
tit="Campana C1 (distesa)"
// distanza tra asse di rotazione e baricentro
// complessivo (campana+ ruota +ceppi)u.m. m
d=0.15
// massa totale(campana+ ruota +ceppi)u.m. kg
m=213
// momento d'inerzia rispetto asse rotazione u.m. kg,m
J=23.18
// metà angolo d'oscillazione %pi/2 per distesa
fimax=%pi/2+0.01

$d := 0.15\ \text{m}$

$m := 213\ \text{kg}$

$J := 23.18\ \text{kg m}^2$

$\varphi_{Max} := 0.5 \cdot \pi + 0.01$

// FINE INPUT
// lunghezza pendolo equivalente
lr=J/(m*d)
om0=sqrt(g/lr)
//
k=sin(fimax/2)
// periodo
T=4/om0*%k(k)
disp(T,"T=")
t=linspace(0,T,500)';

$lr := \frac{J}{m \cdot d} = 0.7255\ \text{m}$

$\omega := \sqrt{\frac{g_e}{lr}} = 3.6765\ \text{Hz}$

$k := \sin\left(0.5 \cdot \varphi_{Max}\right) = 0.7106$

$T := \frac{4}{\omega \cdot k} = 1.531\ \text{s}$

Numerical and symbolic solutions

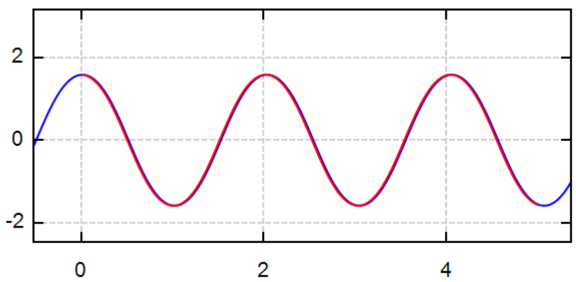
$\varphi''(t) + \omega^2 \cdot \sin(\varphi(t)) = 0$

$\varphi(0) = \varphi_{Max}$ $\quad \varphi'(0) = 0$

$dsolver = \text{"Adams"}$

$RK := \text{dsol}(\varphi(t), 5, 500)$

$\varphi(t) := 2 \cdot \text{asin}(k \cdot \text{sn}(\omega \cdot (t - T), k))$



$\varphi(t\ s)$
augment (col (RK, 1), col (RK, 2))

Numeric

$\tau := \text{col}(RK, 1)\ \text{s}$ $\quad \varphi' := \text{col}(RK, 3)\ \text{Hz}$

$\varphi := \text{col}(RK, 2)$ $\quad \varphi'' := -\omega^2 \cdot \overrightarrow{\sin(\varphi)}$

$H := \overrightarrow{m \cdot d \cdot \left(\varphi'^2 \cdot \sin(\varphi) - \varphi'' \cdot \cos(\varphi)\right)}$ $\quad V := \overrightarrow{m\ g_e + m \cdot d \cdot \left(\varphi'' \cdot \sin(\varphi) + \varphi'^2 \cdot \cos(\varphi)\right)}$

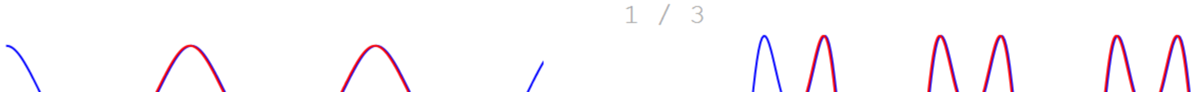
Angular speed and acc

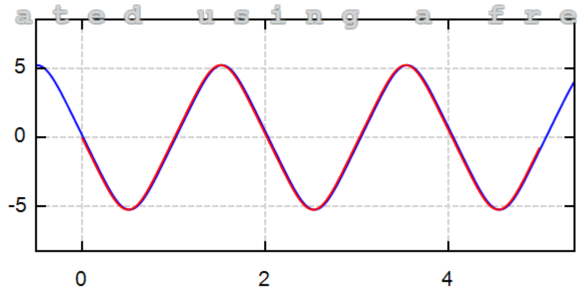
$\varphi'(t) := \frac{2 \cdot k \cdot \omega \cdot \text{cn}(\omega \cdot (t - T), k) \cdot \text{dn}(\omega \cdot (t - T), k)}{\sqrt{1 - k^2 \cdot \text{sn}(\omega \cdot (t - T), k)^2}}$ $\quad \varphi''(t) := -\omega^2 \cdot \sin(\varphi(t))$

Forces

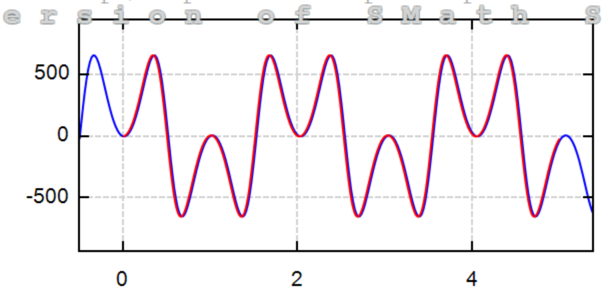
$H(t) := m \cdot d \cdot \left(\varphi'(t)^2 \cdot \sin(\varphi(t)) - \varphi''(t) \cdot \cos(\varphi(t))\right)$

$V(t) := m\ g_e + m \cdot d \cdot \left(\varphi''(t) \cdot \sin(\varphi(t)) + \varphi'(t)^2 \cdot \cos(\varphi(t))\right)$

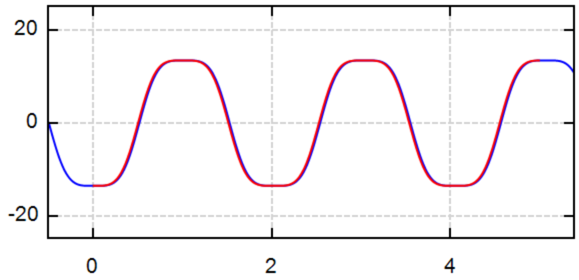




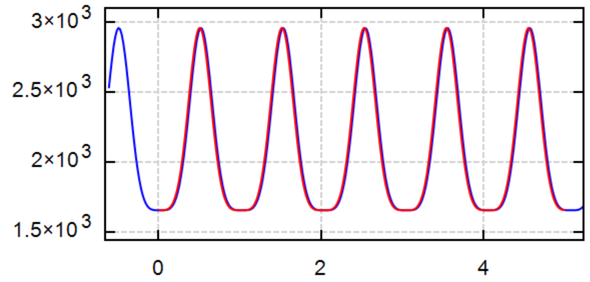
```
{φ'(t s)
{augment(τ, φ')
```



```
{H(t s)
{augment(τ, H)
```



```
{φ''(t s)
{augment(τ, φ'')
```



```
{V(t s)
{augment(τ, V)
```

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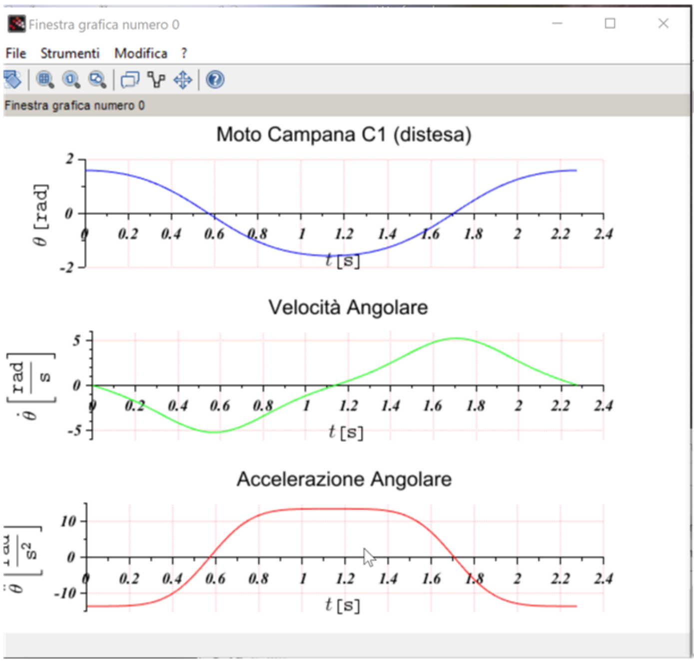
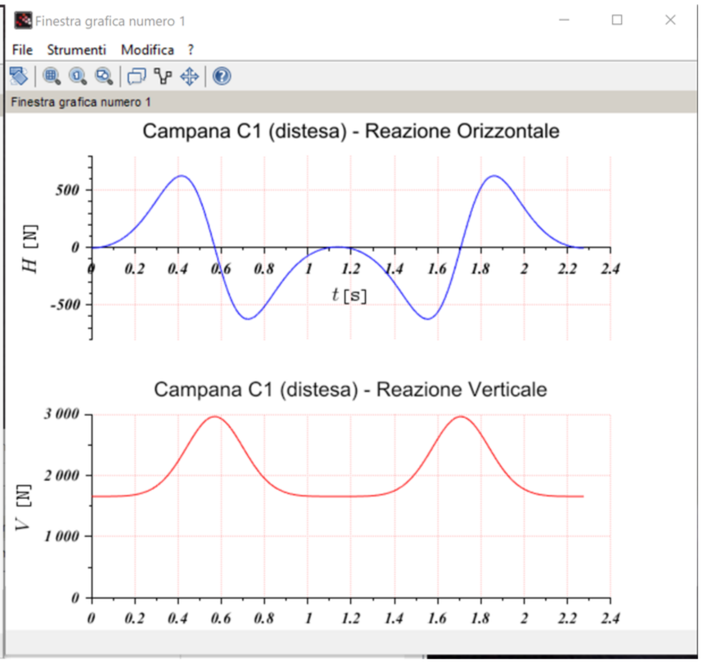
https://en.smath.com/forum/yaf_postsm86613_Problem-in-X-Y-Plot.aspx#post86613






```
clear
global g d m om0 fi0 lr k T
// accelerazione di gravità u.m. m,s
g=9.806
// INPUT
tit="Campana C1 (distesa)"
// distanza tra asse di rotazione e baricentro complessivo (campana+ ruota +ceppi)u.m. m
d=0.15
// massa totale(campana+ ruota +ceppi)u.m. kg
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// FINE INPUT
// lunghezza pendolo equivalente
```

```
lr=J/(m*d)
om0=sqrt(g/lr)
//
k=sin(fimax/2)
// periodo
T=4/om0*%k(k)
disp(T,"T=" )
t=linspace(0,T,500)';

deff('[u]=myplus(x)','u=2*asin(k*ellipj(om0*(x+T/4),k))' )
fi=myplus(t);
//[u]=2*asin(k*ellipj(om0*t,k))
fi1=diag(numderivative(myplus,t));
fi2=-om0^2*sin(fi);
f=1/T
omega=2*%pi/T
// forze all'asse di rotazione
H=-m*d*(fi2.*cos(fi)-fi1.^2 .*sin(fi));
V= m*g+m*d*(fi2.*sin(fi)+fi1.^2 .*cos(fi));
// scomposizione in forzanti sinusoidali per la rappresentazione in serie di Fourier
aH0=1/T*intsplin(t,real(H))
aV0=1/T*intsplin(t,real(V))
n=20
for i=1:n
omegai=i*omega;
integrando1=H .*cos(omegai*t);
integrando2=H .*sin(omegai*t);
aH(i)=2/T*intsplin(t,real(integrando1));
bH(i)=2/T*intsplin(t,real(integrando2));
integrando3=V.*cos(omegai*t);
integrando4=V.*sin(omegai*t);
aV(i)=2/T*intsplin(t,real(integrando3));
bV(i)=2/T*intsplin(t,real(integrando4));
end
aH
bH
aV
bV
```

Alvaro

appVersion(4) = "1.73.9126.0"