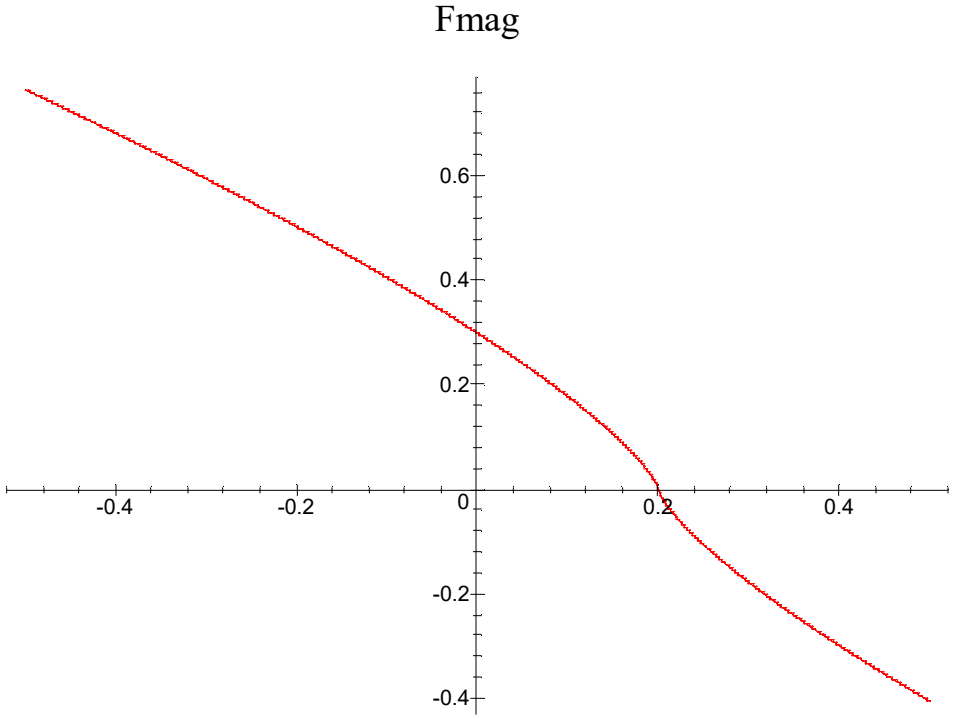
```
STUDENT > # attempt to model magnetic center behavior
STUDENT > # using Fmag = Kmag*(x-xmagcenter)^0.5
STUDENT > # ASSUME coupling is linear
STUDENT >
STUDENT > restart;
STUDENT >
STUDENT > Fmag(x):=-Kmag*abs(x-xmagcenter)^0.75*signum(x-xmagcenter)
          ;
```

$$\mathrm{Fmag}(x) := -Kmag\,\left|x - xmagcenter\right|^{.75}\,\mathrm{signum}(x - xmagcenter)$$

```
STUDENT > System:={Kmag=1,xmagcenter=0.2,Kcoupling=1}; # example
          system values
```

$$System := \{xmagcenter = .2,\ Kcoupling = 1,\ Kmag = 1\}$$

```
STUDENT > plot(subs(System,Fmag(x)),x=-0.5..0.5,title=Fmag,numpoints
          =5000);
```



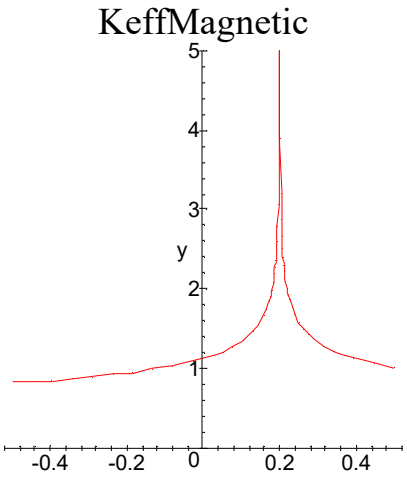

```
STUDENT > KeffMag:=-diff(Fmag(x),x);
```

$$KeffMag := .75\,\frac{Kmag\,\mathrm{signum}(x - xmagcenter)\,\mathrm{abs}(1, x - xmagcenter)}{\left|x - xmagcenter\right|^{.25}} + Kmag\,\left|x - xmagcenter\right|^{.75}\,\mathrm{signum}(1, x - xmagcenter)$$

$$System := \{Kmag = 1,\ xmagcenter = .2\}$$

```
STUDENT >
STUDENT >
STUDENT > plot(subs(System,KeffMag(x)),x=-0.5..0.5,y=0..5,numpoints=
```

```
20,title=KeffMagnetic);
```



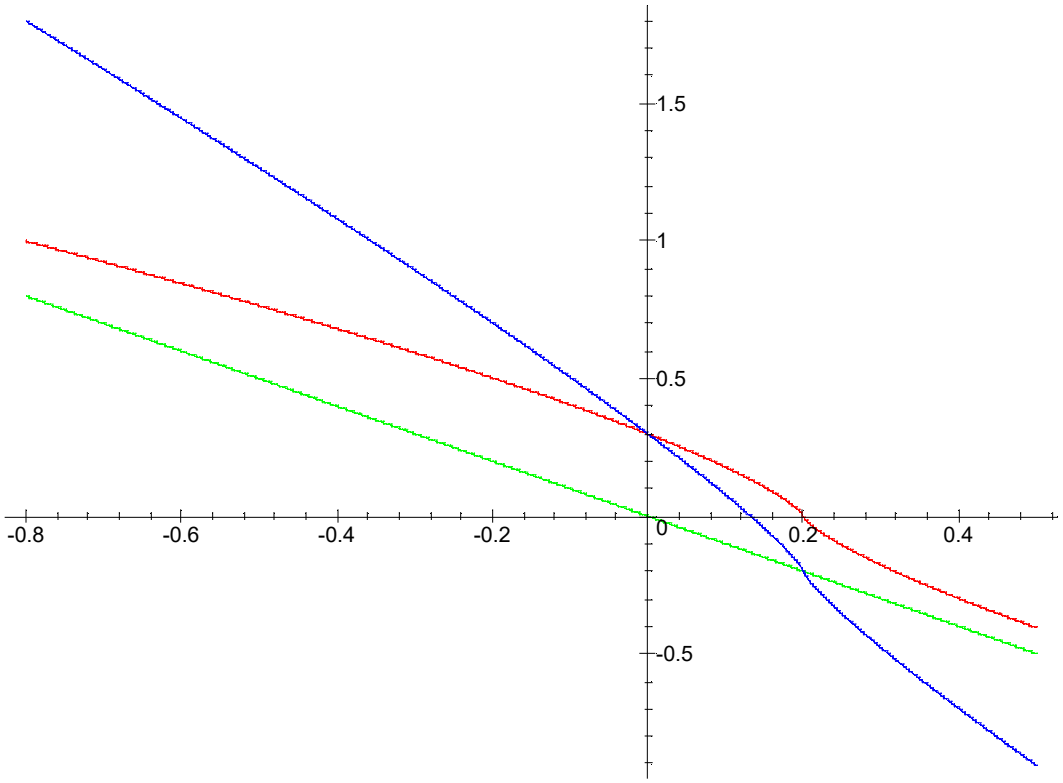

```
STUDENT >
STUDENT > # note above goes infinity at x=0.2 THEORETICALLY from
          math (not actually)
STUDENT > Fcoupling:=-Kcoupling*x;
```

$$Fcoupling := -Kcoupling\, x$$

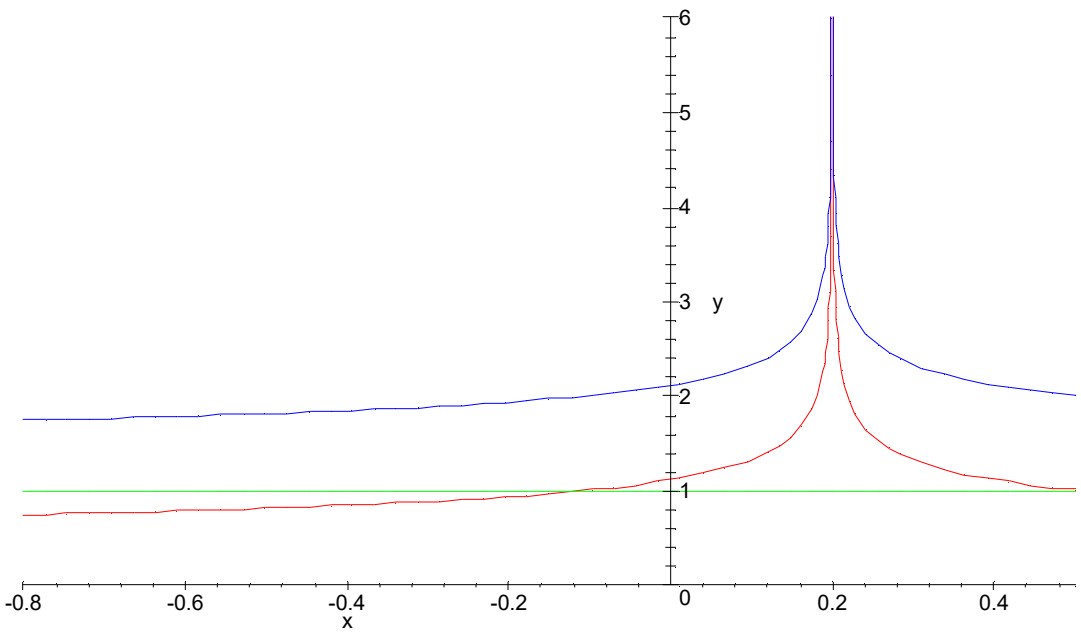
```
STUDENT > Ftotal:=Kcoupling+Fmag(x);
```

$$Ftotal := Kcoupling - Kmag\left|x - xmagcenter\right|^{.75}\,\mathrm{signum}(x - xmagcenter)$$

```
STUDENT > plot([subs(System,Fmag(x)),subs(System,Fcoupling),subs(Sys
          tem,Fcoupling+Fmag(x))],x=-0.8..0.5,numpoints=5000,title=F
          orces,color=['red','green','blue']);
```




```
STUDENT > # observe from above, coupling alone (red) runs at
          equilibrium position 0.2, spring alone (green) runs at
          equilibrium position 0, and spring alone (yellow) runs at
          equilibrium 0, mag alone runs at equilibrium 0.2 (red),
          combination runs at equilibrium ~ 0.1  (green)
STUDENT >
STUDENT > plot([subs(System,KeffMag),subs(System,Kcoupling),subs(Sys
          tem,Kcoupling+KeffMag)],x=-0.8..0.5,y=0..6,title=SpringCon
          stants,color=['red','green','blue']);
```




```
STUDENT > # aboveo red is magnetic, green is couplnig spring
          constant, blue is total
STUDENT >
STUDENT >
STUDENT >
STUDENT >
STUDENT >
STUDENT >
```