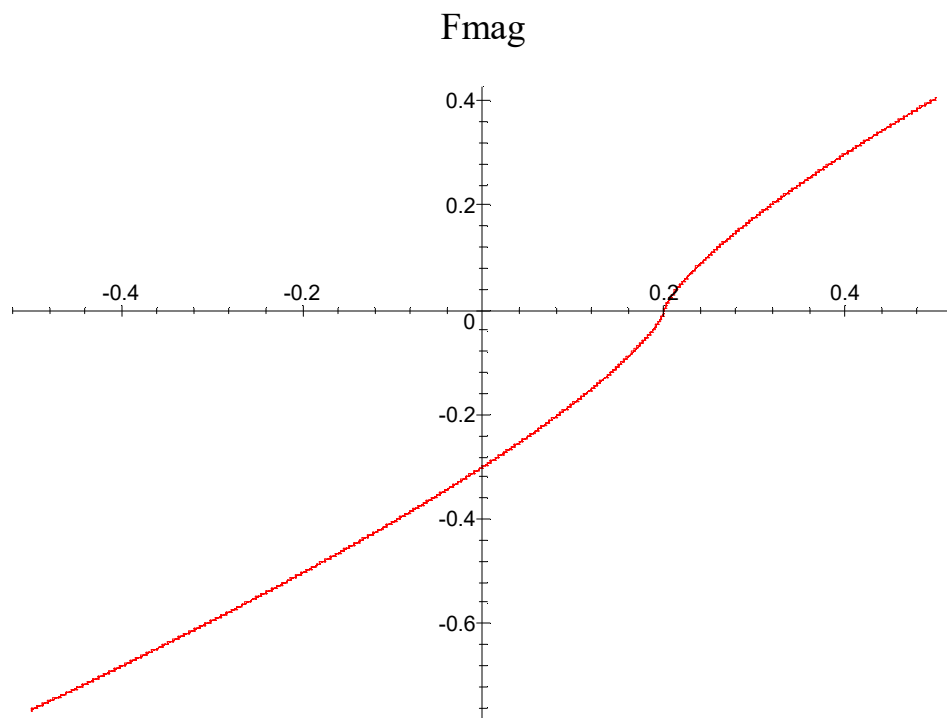```
STUDENT > # attempt to model magnetic center behavior
STUDENT > # using Fmag = Kmag*(x-xmagcenter)^0.5
STUDENT > # ASSUME coupling is linear
STUDENT >
STUDENT > restart;
STUDENT >
STUDENT > Fmag(x):=Kmag*abs(x-xmagcenter)^0.75*signum(x-xmagcenter);
```

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

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

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

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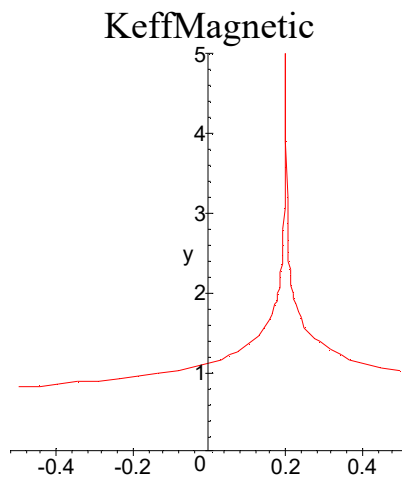

Fmag

```
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);
```

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KeffMagnetic

STUDENT >

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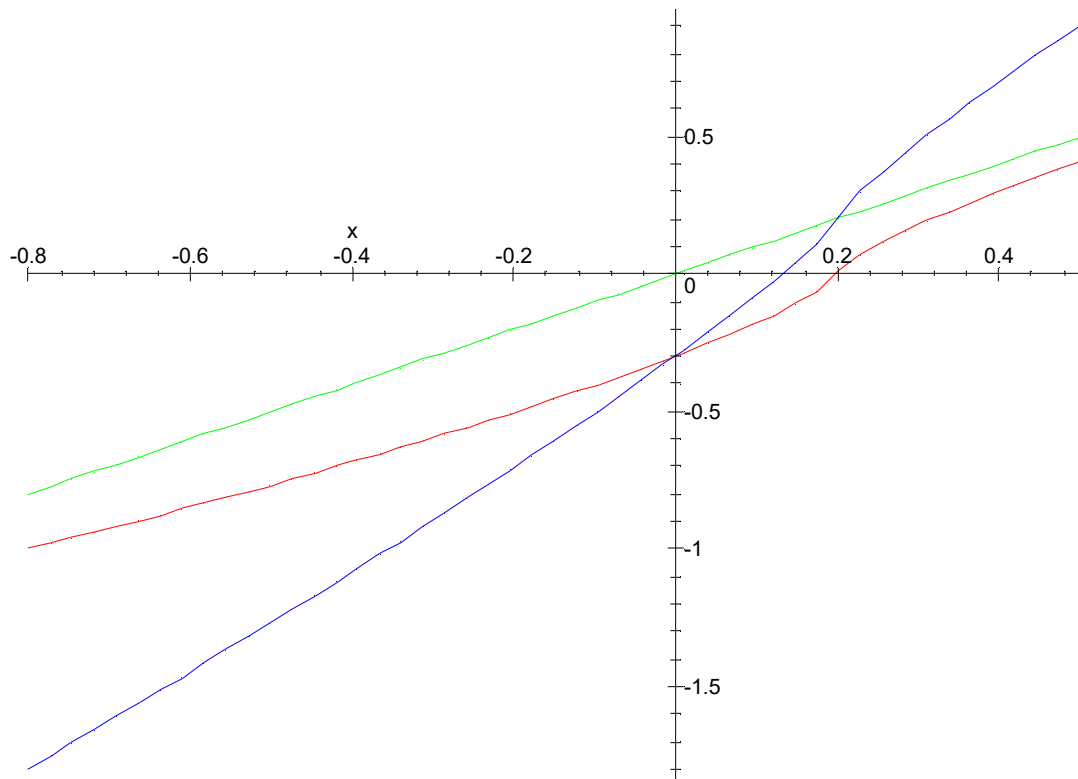
STUDENT > `Fcoupling:=Kcoupling*x;`

$$Fcoupling := Kcoupling\ x$$

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

$$Ftotal := Kcoupling + Kmag\left|x - xmagcenter\right|^{.75} \text{signum}(x - xmagcenter)$$
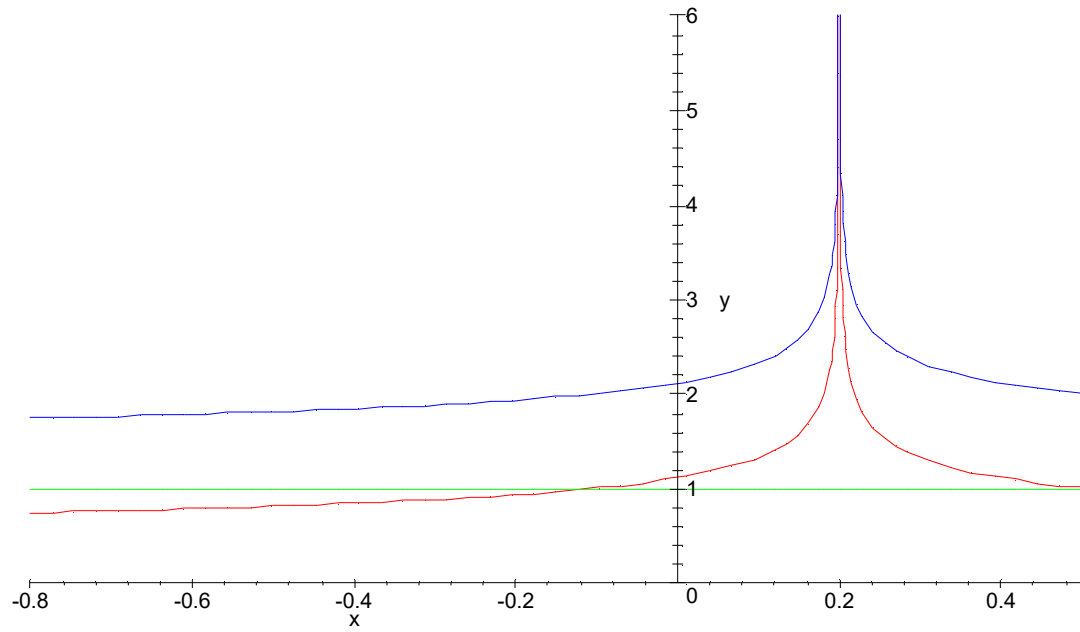
STUDENT > `plot([subs(System,Fmag(x)),subs(System,Fcoupling),subs(System,Fcoupling+Fmag(x))],x=-0.8..0.5,title=Forces,color=['red','green','blue']);`

Forces

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(System,Kcoupling+KeffMag)],x=-0.8..0.5,y=0..6,title=SpringConstants,color=['red','green','blue']);`

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SpringConstants

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

STUDENT >

STUDENT >