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-1

$$\text{deSolve}(y''+k^2 \cdot y=0, x, y)$$

$$y=c_3 \cdot \cos(|k| \cdot x)+c_4 \cdot \sin(|k| \cdot x)$$

$$a \cdot \cos(k \cdot x)+b \cdot \sin(k \cdot x) \rightarrow y$$

$$a \cdot \cos(k \cdot x)+b \cdot \sin(k \cdot x)$$

-----2

-2

$$y=0|x=0$$

$$a=0$$

$$y=0|x=l$$

$$a \cdot \cos(k \cdot l)+b \cdot \sin(k \cdot l)=0$$

-----3

-3

$$\text{solve}\left(\sqrt{\frac{p c r}{e \cdot i}} \cdot l=\pi, p c r\right)$$

$$p c r=\frac{e \cdot i \cdot \pi^2}{l^2} \text{ and } \frac{1}{l} \geq 0$$

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$$\triangle \frac{p c r}{a} | p c r=\frac{e \cdot i \cdot \pi^2}{l^2} \text{ and } i=r^2 \cdot a \text{ and } l=\lambda \cdot r$$

$$\frac{e \cdot \pi^2}{\lambda^2}$$



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$$\text{solve} \left(\begin{cases} ra+rb=p \\ \frac{ra \cdot l}{3} = \frac{rb \cdot 2 \cdot l}{3} \\ \frac{ra}{ea} = \frac{rb}{ea} \end{cases}, \{ra, rb\} \right)$$

$$ea \neq 0 \text{ and } ra = \frac{2 \cdot p}{3} \text{ and } rb = \frac{p}{3}$$

-----2

-2

$$\text{deSolve}(y'' + k^2 \cdot y = 0, x, y)$$

$$y = c7 \cdot \cos(|k| \cdot x) + c8 \cdot \sin(|k| \cdot x)$$

$$a \cdot \sin(k \cdot x) + b \cdot \cos(k \cdot x) \rightarrow y$$

$$b \cdot \cos(k \cdot x) + a \cdot \sin(k \cdot x)$$

-----3

3

$$y=0|x=0$$

$$b=0$$

$$\frac{d}{dx}(y) = 0|x = \frac{l}{3}$$

$$a \cdot k \cdot \cos\left(\frac{k \cdot l}{3}\right) - b \cdot k \cdot \sin\left(\frac{k \cdot l}{3}\right) = 0$$

-----4

-4

$$\triangle \text{ solve} \left(\det \left(\begin{bmatrix} 0 & 1 \\ k \cdot \cos\left(\frac{k \cdot l}{3}\right) & -k \cdot \sin\left(\frac{k \cdot l}{3}\right) \end{bmatrix} \right) = 0, kl \right) | k = \frac{kl}{l}$$

$$kl = \frac{3 \cdot (2 \cdot n1 - 1) \cdot \pi}{2} \text{ or } kl = 0$$

$$\text{solve}\left(k \cdot l = \frac{3 \cdot \pi}{2} p\right) | k = \sqrt{\frac{p}{3 \cdot ei}}$$

$$p = \frac{27 \cdot ei \cdot \pi^2}{4 \cdot l^2} \text{ and } \frac{1}{l} \geq 0$$

$$\text{solve}\left(k \cdot l = \frac{3 \cdot \pi}{2} p\right) | k = \sqrt{\frac{p}{3 \cdot ei}}$$

$$p = \frac{66.6198 \cdot ei}{l^2} \text{ and } \frac{1}{l} \geq 0.$$

□

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1

$$\frac{1}{2} \cdot kr \cdot (\theta_1 + \theta_2)^2 + \frac{1}{2} \cdot kr \cdot (\theta_3 - \theta_2)^2 \rightarrow u$$

$$kr \cdot \left(\frac{\theta_1^2}{2} + \theta_1 \cdot \theta_2 + \theta_2^2 - \theta_2 \cdot \theta_3 + \frac{\theta_3^2}{2} \right)$$

$$-p \cdot \left(\frac{l}{2} \cdot (1 - \cos(\theta_1)) + \frac{l}{3} \cdot (1 - \cos(\theta_2)) + \frac{l}{6} \cdot (1 - \cos(\theta_3)) \right) \rightarrow v$$

$$\frac{l \cdot p \cdot (3 \cdot \cos(\theta_1) + 2 \cdot \cos(\theta_2) + \cos(\theta_3) - 6)}{6}$$

$$u + v \rightarrow ppp$$

$$\frac{l \cdot p \cdot (3 \cdot \cos(\theta_1) + 2 \cdot \cos(\theta_2) + \cos(\theta_3) - 6)}{6} + kr \cdot \left(\frac{\theta_1^2}{2} + \theta_1 \cdot \theta_2 + \theta_2^2 - \theta_2 \cdot \theta_3 + \frac{\theta_3^2}{2} \right)$$

-----2

2

$$\frac{d}{d\theta_1}(ppp) = 0$$

$$\frac{-\sin(\theta_1) \cdot l \cdot p}{2} + \theta_1 \cdot kr + kr \cdot \theta_2 = 0$$

$$\frac{d}{d\theta_2}(ppp) = 0$$

$$\frac{-\sin(\theta_2) \cdot l \cdot p}{3} + 2 \cdot \theta_2 \cdot kr + kr \cdot (\theta_1 - \theta_3) = 0$$

$$\frac{d}{d\theta_3}(ppp) = 0$$

$$\frac{-\sin(\theta_3) \cdot l \cdot p}{6} + \theta_3 \cdot kr - kr \cdot \theta_2 = 0$$

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$$\text{solve}\left(\det\left[\begin{pmatrix} kr - \frac{p \cdot l}{2} & kr & 0 \\ kr & 2 \cdot kr - \frac{p \cdot l}{3} & -kr \\ 0 & -kr & kr - \frac{p \cdot l}{6} \end{pmatrix}\right] = 0, kr\right)$$

$$kr = 0.294599 \cdot l \cdot p \text{ or } kr = 0.09429 \cdot l \cdot p \text{ or } l \cdot p = 0.$$

$$\text{solve}(kr = 0.09429 \cdot l \cdot p, p)$$

$$p = \frac{10.6056 \cdot kr}{l}$$

$$\text{solve}(kr = 0.294599 \cdot l \cdot p, p)$$

$$p = \frac{3.39444 \cdot kr}{l}$$



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$$\theta a - \theta d \rightarrow \theta b$$

$$\theta a - \theta d$$

-----2

2

$$\frac{k \cdot (\theta a + \theta b)^2}{2} + \frac{k \cdot (\theta d - \theta b)^2}{2} \rightarrow u$$

$$k \cdot \left(\frac{5 \cdot \theta a^2}{2} - 4 \cdot \theta a \cdot \theta d + \frac{5 \cdot \theta d^2}{2} \right)$$

$$-p \cdot l \cdot \left(\frac{\theta a^2}{2} + \frac{\theta b^2}{2} + \frac{\theta d^2}{2} \right) \rightarrow v$$

$$-l \cdot p \cdot (\theta a^2 - \theta a \cdot \theta d + \theta d^2)$$

$$u + v \rightarrow ppp$$

$$k \cdot \left(\frac{5 \cdot \theta a^2}{2} - 4 \cdot \theta a \cdot \theta d + \frac{5 \cdot \theta d^2}{2} \right) - l \cdot p \cdot (\theta a^2 - \theta a \cdot \theta d + \theta d^2)$$

-----3

3

$$\frac{d}{d\theta a}(ppp) = 0$$

$$\theta a \cdot (5 \cdot k - 2 \cdot l \cdot p) - 4 \cdot k \cdot \theta d + l \cdot p \cdot \theta d = 0$$

$$\frac{d}{d\theta d}(ppp) = 0$$

$$\theta d \cdot (5 \cdot k - 2 \cdot l \cdot p) - 4 \cdot k \cdot \theta a + l \cdot p \cdot \theta a = 0$$

$$\triangle \text{ solve } \left(\det \begin{pmatrix} 5 \cdot k - 2 \cdot l \cdot p & -4 \cdot k + l \cdot p \\ -4 \cdot k + l \cdot p & 5 \cdot k - 2 \cdot l \cdot p \end{pmatrix} = 0, p \right)$$

\square

$$p = \frac{3 \cdot k}{l} \text{ or } p = \frac{k}{l}$$

-----1. portential

-portential

$$\frac{k \cdot (l \cdot \theta_1)^2}{2} + \frac{2 \cdot k \cdot (l \cdot \theta_2)^2}{2} \rightarrow u$$

$$k \cdot l^2 \cdot \left(\frac{\theta_1^2}{2} + \theta_2^2 \right)$$

$$-p \cdot l \cdot (1 - \cos(\theta_1) + 1 - \cos(\theta_2) + 1 - \cos(\theta_1 - \theta_2)) \rightarrow v$$

$$l \cdot p \cdot (\cos(\theta_1 - \theta_2) + \cos(\theta_1) + \cos(\theta_2) - 3)$$

$$u + v \rightarrow ppp$$

$$k \cdot l^2 \cdot \left(\frac{\theta_1^2}{2} + \theta_2^2 \right) + l \cdot p \cdot (\cos(\theta_1 - \theta_2) + \cos(\theta_1) + \cos(\theta_2) - 3)$$

-----2. characteristic eq

2. characteristic eq

$$\text{taylor}\left(\text{taylor}\left(\frac{d}{d\theta_1}(ppp), \theta_1, 1\right), \theta_2, 1\right)$$

$$(k \cdot l - 2 \cdot p) \cdot l \cdot \theta_1 + \theta_2 \cdot l \cdot p$$

$$\text{taylor}\left(\text{taylor}\left(\frac{d}{d\theta_2}(ppp), \theta_2, 1\right), \theta_1, 1\right)$$

$$2 \cdot (k \cdot l - p) \cdot l \cdot \theta_2 + \theta_1 \cdot l \cdot p$$

-----3. pcr

3. pcr

$$\triangle \text{ solve}\left(\det\left(\begin{bmatrix} k \cdot l^2 - 2 \cdot p \cdot l & p \cdot l \\ p \cdot l & 2 \cdot k \cdot l^2 - 2 \cdot p \cdot l \end{bmatrix}\right) = 0, p\right)$$

$$p = \frac{k \cdot l \cdot (\sqrt{3} + 3)}{3} \text{ or } p = \frac{-k \cdot l \cdot (\sqrt{3} - 3)}{3} \text{ or } l = 0$$

$$\triangle \text{ solve} \left(\det \left(\begin{bmatrix} k \cdot l^2 - 2 \cdot p \cdot l & p \cdot l \\ p \cdot l & 2 \cdot k \cdot l^2 - 2 \cdot p \cdot l \end{bmatrix} \right) = 0, p \right)$$

$$p = 1.57735 \cdot k \cdot l \text{ or } p = 0.42265 \cdot k \cdot l \text{ or } l = 0.$$

-----4. mode vector

4. mode vector

$$\text{solve}((k \cdot l - 2 \cdot p) \cdot l \cdot \theta_1 + \theta_2 \cdot l \cdot p = 0, \theta_2) | p = 0.42265 \cdot k \cdot l \text{ and } \theta_1 = 1$$

$$\theta_2 = -0.366024 \text{ or } k \cdot l^2 = 0.$$

$$\text{solve}((k \cdot l - 2 \cdot p) \cdot l \cdot \theta_1 + \theta_2 \cdot l \cdot p = 0, \theta_2) | p = 1.57735 \cdot k \cdot l \text{ and } \theta_1 = 1$$

$$\theta_2 = 1.36603 \text{ or } k \cdot l^2 = 0.$$

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$$\text{deSolve}(y''+k^2 \cdot y+k^2 \cdot e=0,x,y)$$

$$y=c1 \cdot \cos(|k| \cdot x)+c2 \cdot \sin(|k| \cdot x)-e$$

$$a \cdot \sin(k \cdot x)+b \cdot \cos(k \cdot x)-e \rightarrow y$$

$$b \cdot \cos(k \cdot x)+a \cdot \sin(k \cdot x)-e$$

-----2

2

$$\text{solve}\left(\left\{\begin{array}{l} (y|x=0)=0 \\ (y|x=l)=0 \end{array}\right\}, \{a,b\}\right)$$

$$a=e \cdot \tan\left(\frac{k \cdot l}{2}\right) \text{ and } b=e$$

$$\text{expand}\left(y|a=e \cdot \tan\left(\frac{k \cdot l}{2}\right) \text{ and } b=e\right) \rightarrow yy$$



$$e \cdot \cos(k \cdot x) + \frac{e \cdot \sin\left(\frac{k \cdot l}{2}\right) \cdot \sin(k \cdot x)}{\cos\left(\frac{k \cdot l}{2}\right)} - e$$

-----3

3

$$yy|x=\frac{l}{2}$$

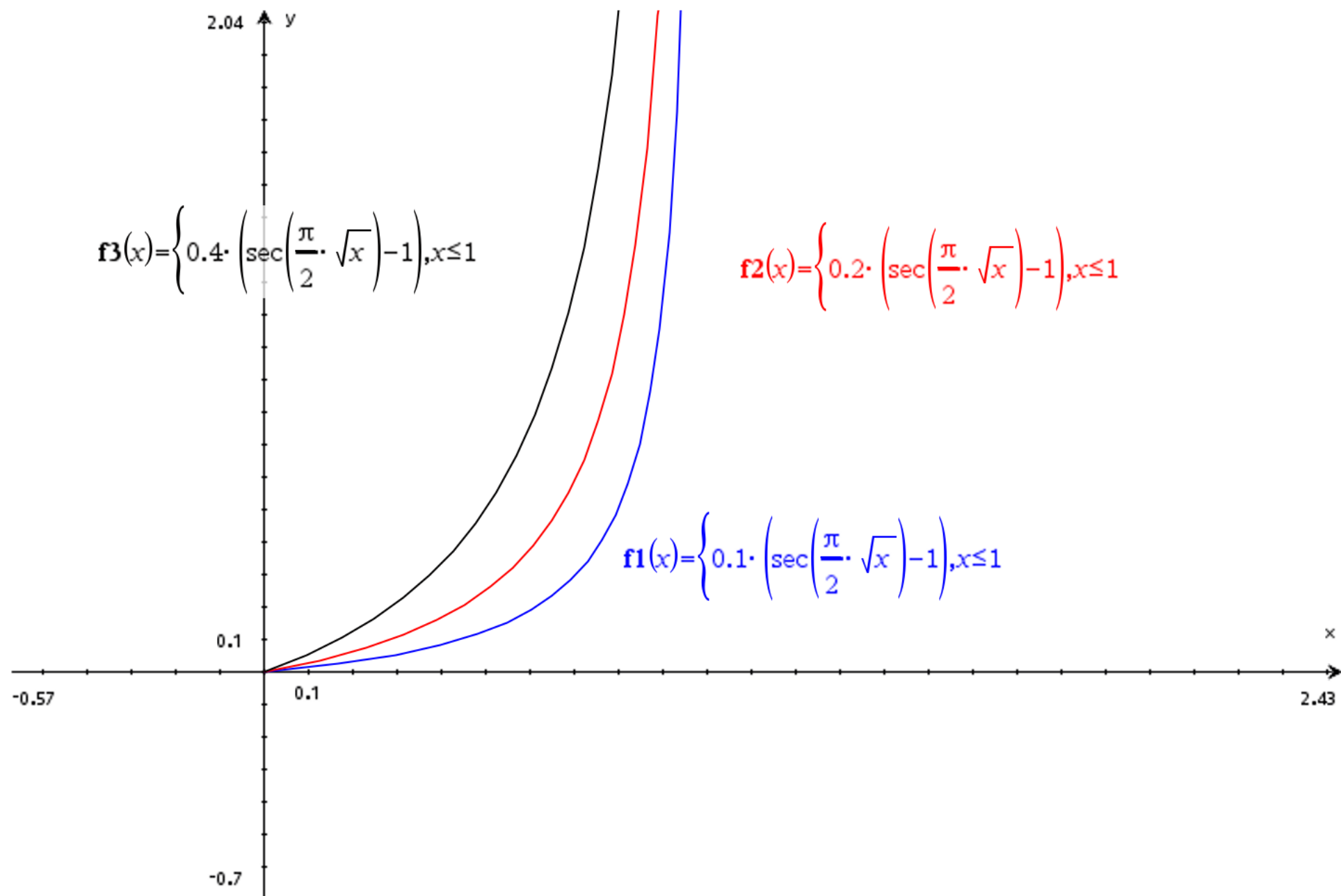
$$\frac{-e \cdot \left(\cos\left(\frac{k \cdot l}{2}\right)-1\right)}{\cos\left(\frac{k \cdot l}{2}\right)}$$



$$\frac{-e \cdot \left(\cos\left(\frac{k \cdot l}{2}\right) - 1 \right)}{\cos\left(\frac{k \cdot l}{2}\right)} \Big|_{k = \sqrt{\frac{p}{ei}}} \text{ and } ei = \frac{p \cdot cr \cdot l^2}{\pi^2}$$

$$\frac{-e \cdot \left(\cos\left(\frac{\sqrt{\frac{p}{p \cdot cr}} \cdot \pi}{2}\right) - 1 \right)}{\cos\left(\frac{\sqrt{\frac{p}{p \cdot cr}} \cdot \pi}{2}\right)}$$





-----1

1

$$\text{deSolve}(y'' + k^2 \cdot y + k^2 \cdot e = 0, x, y)$$

$$y = c1 \cdot \cos(|k| \cdot x) + c2 \cdot \sin(|k| \cdot x) - e$$

$$a \cdot \sin(k \cdot x) + b \cdot \cos(k \cdot x) - e \rightarrow y$$

$$b \cdot \cos(k \cdot x) + a \cdot \sin(k \cdot x) - e$$

-----2

2

$$\text{solve}\left(\left\{\begin{array}{l} (y|x=0)=0 \\ (y|x=l)=0 \end{array}\right\}, \{a, b\}\right)$$

$$a = e \cdot \tan\left(\frac{k \cdot l}{2}\right) \text{ and } b = e$$

$$\text{expand}\left(y|a = e \cdot \tan\left(\frac{k \cdot l}{2}\right) \text{ and } b = e\right) \rightarrow yy$$



$$e \cdot \cos(k \cdot x) + \frac{e \cdot \sin\left(\frac{k \cdot l}{2}\right) \cdot \sin(k \cdot x)}{\cos\left(\frac{k \cdot l}{2}\right)} - e$$

-----3

3

$$yy|x = \frac{l}{2}$$

$$\frac{-e \cdot \left(\cos\left(\frac{k \cdot l}{2}\right) - 1\right)}{\cos\left(\frac{k \cdot l}{2}\right)}$$



$$\frac{-e \cdot \left(\cos\left(\frac{k \cdot l}{2}\right) - 1 \right)}{\cos\left(\frac{k \cdot l}{2}\right)} \Big|_{k = \sqrt{\frac{p}{ei}}} \text{ and } ei = \frac{p \cdot cr \cdot l^2}{\pi^2}$$

$$\frac{-e \cdot \left(\cos\left(\frac{\sqrt{\frac{p}{p \cdot cr}} \cdot \pi}{2}\right) - 1 \right)}{\cos\left(\frac{\sqrt{\frac{p}{p \cdot cr}} \cdot \pi}{2}\right)}$$



-----1.1

1.1

$$\text{deSolve}(y'' + k^2 \cdot y + k^2 \cdot e = 0, x, y)$$

$$y = c1 \cdot \cos(|k| \cdot x) + c2 \cdot \sin(|k| \cdot x) - e$$

$$a \cdot \sin(k \cdot x) + b \cdot \cos(k \cdot x) - e \rightarrow y$$

$$b \cdot \cos(k \cdot x) + a \cdot \sin(k \cdot x) - e$$

-----1.2

1.2

$$\text{solve}\left(\left\{\begin{array}{l} (y|x=0)=0 \\ (y|x=l)=0 \end{array}\right\}, \{a, b\}\right)$$

$$a = e \cdot \tan\left(\frac{k \cdot l}{2}\right) \text{ and } b = e$$

-----1.3

1.3

$$\text{expand}\left(y|a = e \cdot \tan\left(\frac{k \cdot l}{2}\right) \text{ and } b = e\right) \rightarrow yy$$



$$e \cdot \cos(k \cdot x) + \frac{e \cdot \sin\left(\frac{k \cdot l}{2}\right) \cdot \sin(k \cdot x)}{\cos\left(\frac{k \cdot l}{2}\right)} - e$$

-----1.4

1.4

$$yy|x = \frac{l}{2}$$

$$\frac{-e \cdot \left(\cos\left(\frac{k \cdot l}{2}\right) - 1\right)}{\cos\left(\frac{k \cdot l}{2}\right)}$$

⚠
$$\frac{-e \cdot \left(\cos\left(\frac{k \cdot l}{2}\right) - 1 \right)}{\cos\left(\frac{k \cdot l}{2}\right)} \Big|_{k=\sqrt{\frac{p}{ei}}} \text{ and } ei = \frac{p \cdot cr \cdot l^2}{\pi^2} \rightarrow y_{max}$$

$$\frac{-e \cdot \left(\cos\left(\frac{\sqrt{\frac{p}{p \cdot cr}} \cdot \pi}{2}\right) - 1 \right)}{\cos\left(\frac{\sqrt{\frac{p}{p \cdot cr}} \cdot \pi}{2}\right)}$$

-----2

2

$$\frac{\pi^2 \cdot ei}{l^2} \Big|_{l=400} \text{ and } ei = \frac{200000 \cdot 200^2}{12} \rightarrow p_{cr}$$

41123.352

-----3

3

$$200000 \cdot 200 \cdot 10 \cdot 10^{-6} \cdot 30 \rightarrow p$$

12000.

-----4

4

$$y_{max} | e=1$$

0.51265744

-----5

5

$$\frac{p}{a}\cdot\left(1+\frac{1\cdot5\cdot\sqrt{2}}{\frac{i}{a}}\cdot\sec\left(\frac{\pi}{2}\cdot\sqrt{\frac{p}{pcr}}\right)\right)|_{a=200\text{ and }i=\frac{200^2}{12}}$$

98.505972

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-1

$$a \cdot \sin(k \cdot x) + b \cdot \cos(k \cdot x) - \frac{x}{2} \rightarrow y1$$

$$b \cdot \cos(k \cdot x) + a \cdot \sin(k \cdot x) - \frac{x}{2}$$

$$c \cdot \sin(k \cdot x) + d \cdot \cos(k \cdot x) - \frac{3 \cdot x}{2} \rightarrow y2$$

$$d \cdot \cos(k \cdot x) + c \cdot \sin(k \cdot x) - \frac{3 \cdot x}{2}$$

-----2

-2

$$y1=0|x=0$$

$$b=0$$

$$y2=0|x=0$$

$$d=0$$

$$\text{solve} \left(\left(\begin{array}{l} (y1|x=3 \cdot l) = (y2|x=l) \\ \left(\frac{d}{dx}(y1)|_{x=3 \cdot l} \right) = - \left(\frac{d}{dx}(y2)|_{x=l} \right) \end{array} \right), \{a, c\} \right) | b=0 \text{ and } d=0$$

$$a = \frac{2 \cdot \sin(k \cdot l)}{k \cdot (\sin(k \cdot l) \cdot \cos(3 \cdot k \cdot l) + \cos(k \cdot l) \cdot \sin(3 \cdot k \cdot l))} \text{ and } c = \frac{2 \cdot \sin(3 \cdot k \cdot l)}{k \cdot (\sin(k \cdot l) \cdot \cos(3 \cdot k \cdot l) + \cos(k \cdot l) \cdot \sin(3 \cdot k \cdot l))}$$

$$\text{tCollect} \left(a = \frac{2 \cdot \sin(k \cdot l)}{k \cdot (\sin(k \cdot l) \cdot \cos(3 \cdot k \cdot l) + \cos(k \cdot l) \cdot \sin(3 \cdot k \cdot l))} \text{ and } c = \frac{2 \cdot \sin(3 \cdot k \cdot l)}{k \cdot (\sin(k \cdot l) \cdot \cos(3 \cdot k \cdot l) + \cos(k \cdot l) \cdot \sin(3 \cdot k \cdot l))} \right)$$

$$a = \frac{2 \cdot \sin(k \cdot l)}{k \cdot \sin(4 \cdot k \cdot l)} \text{ and } c = \frac{2 \cdot \sin(3 \cdot k \cdot l)}{k \cdot \sin(4 \cdot k \cdot l)}$$

-----3

-3

$$\text{⚠ expand}\left(y1|a=\frac{2\cdot\sin(k\cdot l)}{k\cdot\sin(4\cdot k\cdot l)}\text{ and }c=\frac{2\cdot\sin(3\cdot k\cdot l)}{k\cdot\sin(4\cdot k\cdot l)}\text{ and }b=0\text{ and }d=0\right)\rightarrow y11$$

$$\frac{2\cdot\sin(k\cdot l)\cdot\sin(k\cdot x)}{k\cdot\sin(4\cdot k\cdot l)}-\frac{x}{2}$$

$$\text{⚠ expand}\left(y2|a=\frac{2\cdot\sin(k\cdot l)}{k\cdot\sin(4\cdot k\cdot l)}\text{ and }c=\frac{2\cdot\sin(3\cdot k\cdot l)}{k\cdot\sin(4\cdot k\cdot l)}\text{ and }b=0\text{ and }d=0\right)\rightarrow y22$$

$$\frac{2\cdot\sin(3\cdot k\cdot l)\cdot\sin(k\cdot x)}{k\cdot\sin(4\cdot k\cdot l)}-\frac{3\cdot x}{2}$$

$$\text{⚠ expand}\left(\frac{d}{dx}(y11)\right)\rightarrow\theta11$$

$$\frac{2\cdot\sin(k\cdot l)\cdot\cos(k\cdot x)}{\sin(4\cdot k\cdot l)}-\frac{1}{2}$$

$$\text{⚠ expand}\left(\frac{d}{dx}(y22)\right)\rightarrow\theta22$$

$$\frac{2\cdot\sin(3\cdot k\cdot l)\cdot\cos(k\cdot x)}{\sin(4\cdot k\cdot l)}-\frac{3}{2}$$

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$$\frac{4 \cdot ei \cdot \theta a}{l} \rightarrow m0$$

$$\frac{4 \cdot ei \cdot \theta a}{l}$$

-----2

2

$$\triangle \text{ deSolve} \left(y'' + k^2 \cdot y = \frac{k^2 \cdot m0}{p}, x, y \right) | k > 0 \text{ and } p = k^2 \cdot ei$$

$$y = c9 \cdot \cos(k \cdot x) + c10 \cdot \sin(k \cdot x) + \frac{4 \cdot \theta a}{k^2 \cdot l} \text{ and } k > 0$$

$$b \cdot \cos(k \cdot x) + a \cdot \sin(k \cdot x) + \frac{4 \cdot \theta a}{k^2 \cdot l} \rightarrow y$$

$$b \cdot \cos(k \cdot x) + a \cdot \sin(k \cdot x) + \frac{4 \cdot \theta a}{k^2 \cdot l}$$

-----3

-3

$$y=0|x=0$$

$$b + \frac{4 \cdot \theta a}{k^2 \cdot l} = 0$$

$$\triangle \frac{d}{dx}(y) - \theta a = 0|x=0$$


$$a \cdot k - \theta a = 0$$

$$\triangle y - \frac{m0}{p} | x = 2 \cdot l \text{ and } p = k^2 \cdot ei$$

$$a \cdot \sin(2 \cdot k \cdot l) + b \cdot \cos(2 \cdot k \cdot l)$$

-----4


-4

 solve $\left(\det \begin{pmatrix} 0 & 1 & \frac{4}{k^2 \cdot l} \\ k & 0 & -1 \\ \sin(2 \cdot k \cdot l) & \cos(2 \cdot k \cdot l) & 0 \end{pmatrix} = 0, kl \right) | k = \frac{kl}{l} \text{ and } kl > 0$

$kl = 0.698908$ or $kl = 2.11318$ or $kl = 3.56314$ or $kl = 5.04746$ or $kl = 6.55707$ or $kl = 8.08373$ or $kl = 9.62177$ or $kl = 11.1675$ ▶

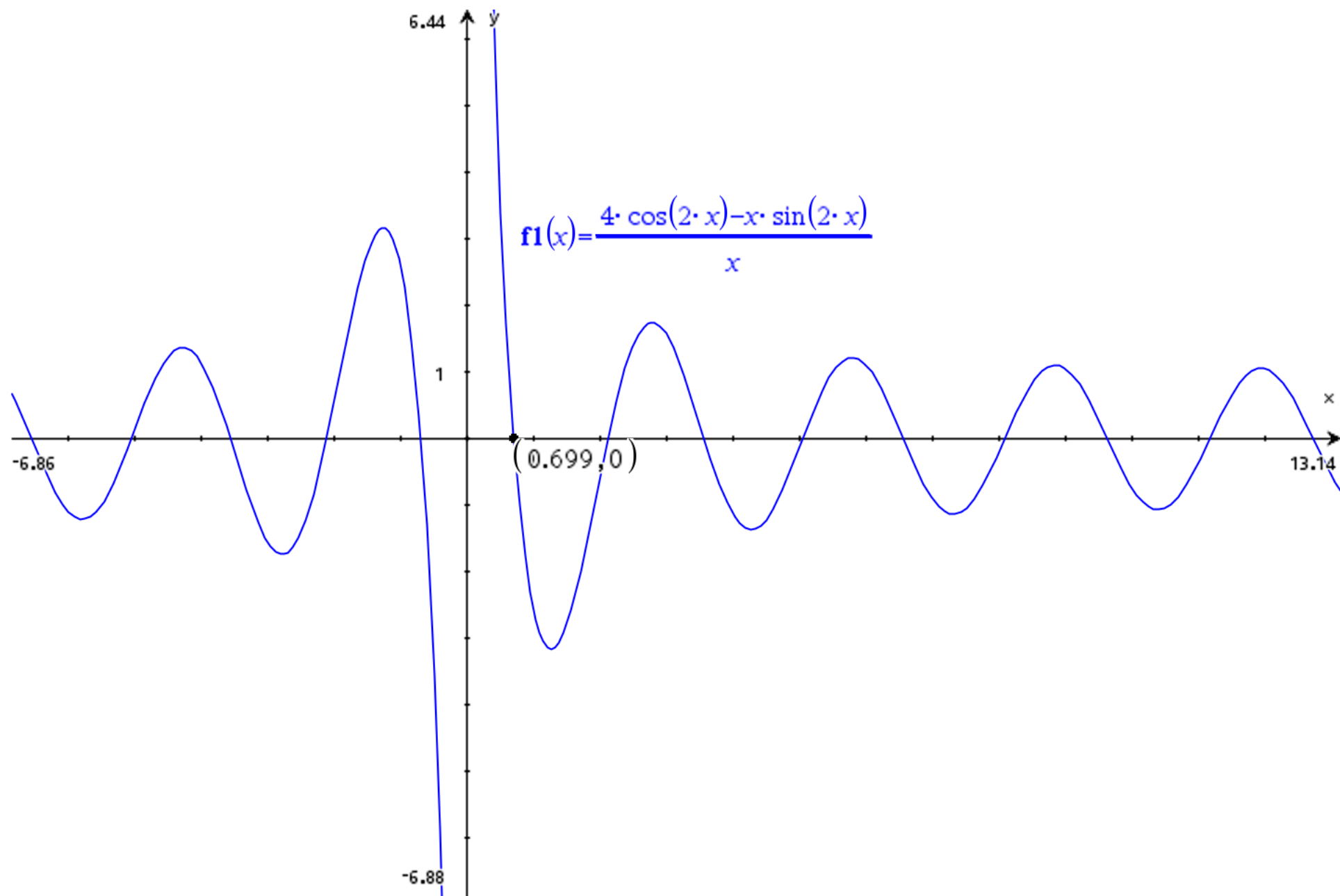
solve $(0.698908 = k \cdot l, p) | k = \sqrt{\frac{p}{ei}}$

$p = \frac{0.488472 \cdot ei}{l^2} \text{ and } \frac{1}{l} \geq 0.$

 $\det \begin{pmatrix} 0 & 1 & \frac{4}{k^2 \cdot l} \\ k & 0 & -1 \\ \sin(2 \cdot k \cdot l) & \cos(2 \cdot k \cdot l) & 0 \end{pmatrix} | k = \frac{kl}{l} \text{ and } kl = x$

$\frac{4 \cdot \cos(2 \cdot x) - x \cdot \sin(2 \cdot x)}{x}$

[]



-----1

-1

$$\text{solve}\left(\frac{4 \cdot ei}{l} \cdot \theta a = p \cdot \delta, \theta a\right)$$

$$\theta a = \frac{l \cdot p \cdot \delta}{4 \cdot ei}$$

-----2

-2

$$\frac{5}{12 \cdot ei} \cdot p \cdot \delta \cdot 1 \cdot 2 \cdot l \cdot 2 \cdot l \rightarrow yb$$

$$\frac{5 \cdot l^2 \cdot p \cdot \delta}{3 \cdot ei}$$

-----3

-3

$$yb + x \cdot \theta a | \theta a = \frac{l \cdot p \cdot \delta}{4 \cdot ei} \rightarrow y$$

$$\frac{l \cdot p \cdot \delta \cdot x}{4 \cdot ei} + \frac{5 \cdot l^2 \cdot p \cdot \delta}{3 \cdot ei}$$

-----4

-4

$$\text{solve}((y|x=2 \cdot l) = \delta, p)$$

$$p = \frac{6 \cdot ei}{13 \cdot l^2}$$

$$p = \frac{6 \cdot ei}{13 \cdot l^2}$$

$$p = \frac{0.46153846 \cdot ei}{l^2}$$

-----1

1

$$\text{solve}\left(m0 = \frac{2 \cdot ei}{l} \cdot 2 \cdot \theta, \theta\right)$$

$$\theta = \frac{l \cdot m0}{4 \cdot ei}$$

-----2

2

$$\text{deSolve}\left(y'' + k^2 \cdot y - \frac{m0}{ei} = 0, x, y\right) | k > 0$$

$$y = c3 \cdot \cos(k \cdot x) + c4 \cdot \sin(k \cdot x) + \frac{m0}{k^2 \cdot ei} \text{ and } k > 0$$

$$a \cdot \sin(k \cdot x) + b \cdot \cos(k \cdot x) + \frac{m0}{k^2 \cdot ei} \rightarrow y1$$

$$b \cdot \cos(k \cdot x) + a \cdot \sin(k \cdot x) + \frac{m0}{k^2 \cdot ei}$$

-----3

3

$$\begin{cases} y1 = 0 | x = 0 \\ y1 = 0 | x = l \\ \frac{d}{dx}(y1) = \theta | x = 0 \end{cases}$$

$$\left\{ b + \frac{m0}{k^2 \cdot ei} = 0, a \cdot \sin(k \cdot l) + b \cdot \cos(k \cdot l) + \frac{m0}{k^2 \cdot ei} = 0, a \cdot k = \theta \right\}$$

-----4

4

$$\Delta \det \begin{pmatrix} 0 & 1 & \frac{1}{k^2 \cdot ei} \\ \sin(k \cdot l) & \cos(k \cdot l) & \frac{1}{k^2 \cdot ei} \\ k & 0 & \frac{-l}{4 \cdot ei} \end{pmatrix} \Big|_{kl=x \text{ and } k=\frac{x}{l}} \quad \frac{-l \cdot (4 \cdot \cos(x) - x \cdot \sin(x) - 4)}{4 \cdot ei \cdot x}$$

$$\Delta \text{solve} \left(\frac{-l \cdot (4 \cdot \cos(x) - x \cdot \sin(x) - 4)}{4 \cdot ei \cdot x} = 0, x \right)$$

$x=1.17549\text{E-}38$ and $ei \neq 0$. or $x=4.57786$ and $ei \neq 0$. or $x=6.28319$ and $ei \neq 0$. or $x=10.174$ and $ei \neq 0$. or $x=12.5664$ and l

$$\text{solve} \left(l \cdot \sqrt{\frac{p}{ei}} = 4.577859, p \right) \quad p = \frac{20.9568 \cdot ei}{l^2} \text{ and } \frac{1}{l} \geq 0.$$

$$\text{solve} \left(\frac{\pi^2 \cdot ei}{(c \cdot l)^2} = \frac{20.9568 \cdot ei}{l^2}, c \right) \quad c = -0.686258 \text{ or } c = 0.686258$$

[]

-----1

1

-----2

-2

$$a \cdot \sin(k \cdot x) + b \cdot \cos(k \cdot x) + \frac{m_0}{p} \rightarrow y$$

$$b \cdot \cos(k \cdot x) + a \cdot \sin(k \cdot x) + \frac{m_0}{p}$$

-----3

3

$$y=0|x=0$$

$$b + \frac{m_0}{p} = 0$$

$$\triangle \frac{d}{dx}(y) = 0|x = \frac{l}{2}$$


$$a \cdot k \cdot \cos\left(\frac{k \cdot l}{2}\right) - b \cdot k \cdot \sin\left(\frac{k \cdot l}{2}\right) = 0$$

$$\triangle \frac{d}{dx}(y) - \theta = 0|x=0 \text{ and } \theta = \frac{m_0 \cdot k^2 \cdot l}{8 \cdot p}$$

$$a \cdot k - \frac{k^2 \cdot l \cdot m_0}{8 \cdot p} = 0$$

-----4

-4




$$\text{solve} \left(\det \begin{pmatrix} 0 & 1 & \frac{1}{k^2 \cdot ei} \\ \sin(k \cdot l) & \cos(k \cdot l) & \frac{1}{k^2 \cdot ei} \\ k & 0 & \frac{-l}{8 \cdot ei} \end{pmatrix} = 0, kl \mid k = \frac{kl}{l} \text{ and } 0 < kl < 6 \right)$$

$0 < kl < 6$ and $l = 0$ or $kl = 1.E-38$ and $ei \neq 0$. or $kl = 5.14086$ and $ei \neq 0$.

-----ex

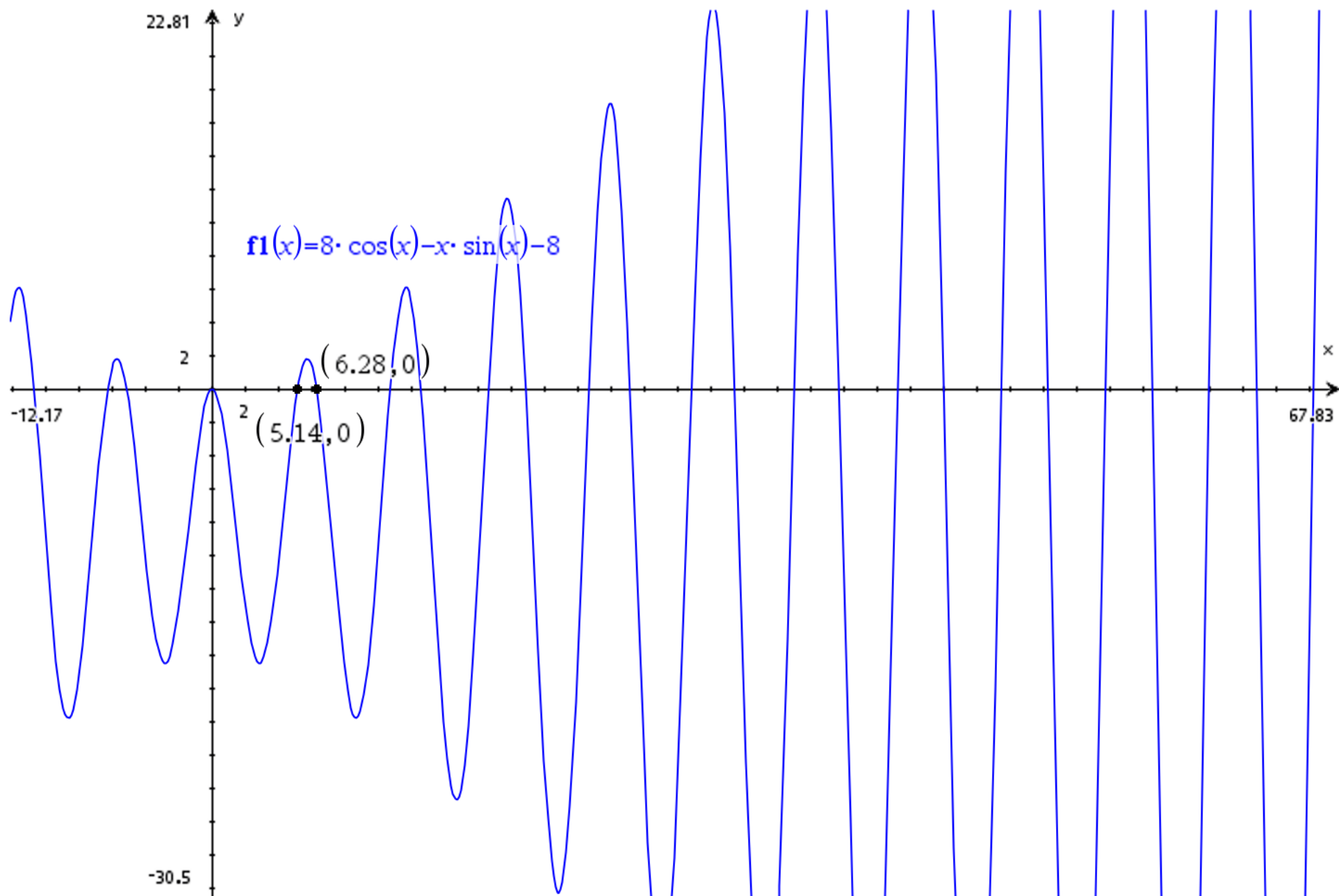
-ex



$$\text{solve} \left(\det \begin{pmatrix} 0 & 1 & \frac{1}{k^2 \cdot ei} \\ \sin(k \cdot l) & \cos(k \cdot l) & \frac{1}{k^2 \cdot ei} \\ k & 0 & \frac{-l}{8 \cdot ei} \end{pmatrix} = 0, kl \mid k = \frac{kl}{l} \right)$$

$kl = 1.17549E-38$ and $ei \neq 0$. or $kl = 6.28319$ and $ei \neq 0$. or $kl = 10.7081$ and $ei \neq 0$. or $kl = 12.5664$ and $ei \neq 0$. or $kl = 16.6059$ ▶

[]



11-applied-3

-----1

-1

$$b \cdot \cos(k \cdot x) + \delta + \frac{l}{2} \cdot \theta \rightarrow y1$$

$$b \cdot \cos(k \cdot x) + \frac{l \cdot \theta}{2} + \delta$$

-----2

-2

$$y1=0|x=0$$

$$b + \frac{l \cdot \theta}{2} + \delta = 0$$

$$y1=\delta|x=l$$


$$b \cdot \cos(k \cdot l) + \frac{l \cdot \theta}{2} + \delta = \delta$$

$$\frac{d}{dx}(y1) = \theta|x=l$$

$$-b \cdot k \cdot \sin(k \cdot l) = \theta$$

-----3

-3

 solve $\det \left(\begin{bmatrix} 1 & 1 & \frac{l}{2} \\ \cos(k \cdot l) & 0 & \frac{l}{2} \\ -k \sin(k \cdot l) & 0 & -1 \end{bmatrix} \right) = 0, kl \mid l = \frac{kl}{k} \text{ and } kl > 0$

$kl=1.07687$ or $kl=3.6436$ or $kl=6.57833$ or $kl=9.62956$ or $kl=12.7223$ or $kl=15.8336$ or $kl=18.9547$ or $kl=22.0815$ or

$$\text{solve}(k \cdot l = 1.07687, p) | k = \sqrt{\frac{p}{ei}}$$

$$p = \frac{1.15965 \cdot ei}{l^2} \text{ and } \frac{1}{l} \geq 0.$$

[]

$$\text{-----}1$$

1

$$a \cdot \sin(k \cdot x) + b \cdot \cos(k \cdot x) + \delta \rightarrow y1$$

$$b \cdot \cos(k \cdot x) + a \cdot \sin(k \cdot x) + \delta$$

$$\text{-----}2$$

2

$$c \cdot \sin\left(\frac{k \cdot x}{3}\right) + d \cdot \cos\left(\frac{k \cdot x}{3}\right) + \delta \rightarrow y2$$

$$d \cdot \cos\left(\frac{k \cdot x}{3}\right) + c \cdot \sin\left(\frac{k \cdot x}{3}\right) + \delta$$

$$\text{-----}3$$

3

$$\text{solve}((y2|x=0)=0, d)$$

$$d = -\delta$$

$$\text{solve}\left(\left(\frac{d}{dx}(y2)|x=0\right)=0, c\right)|d=-\delta$$

$$c=0 \text{ or } k=0$$

$$-\delta \cdot \cos\left(\frac{k \cdot x}{3}\right) + \delta \rightarrow y2$$

$$\delta - \delta \cdot \cos\left(\frac{k \cdot x}{3}\right)$$

$$(y1|x=l) - \delta$$


$$a \cdot \sin(k \cdot l) + b \cdot \cos(k \cdot l)$$

$$\left(y1|x=\frac{3 \cdot l}{4}\right) - \left(y2|x=\frac{3}{4} \cdot l\right)$$

$$a \cdot \sin\left(\frac{3 \cdot k \cdot l}{4}\right) + b \cdot \cos\left(\frac{3 \cdot k \cdot l}{4}\right) + \cos\left(\frac{k \cdot l}{4}\right) \cdot \delta$$


$$\left(\frac{d}{dx}(y1)\right)_{x=\frac{3 \cdot l}{4}} - \left(\frac{d}{dx}(y2)\right)_{x=\frac{3 \cdot l}{4}}$$

$$a \cdot k \cdot \cos\left(\frac{3 \cdot k \cdot l}{4}\right) - b \cdot k \cdot \sin\left(\frac{3 \cdot k \cdot l}{4}\right) - \frac{k \cdot \sin\left(\frac{k \cdot l}{4}\right) \cdot \delta}{3}$$




$$\det \begin{pmatrix} \sin(kl) & \cos(kl) & 0 \\ \sin\left(\frac{3 \cdot kl}{4}\right) & \cos\left(\frac{3 \cdot kl}{4}\right) & \cos\left(\frac{kl}{4}\right) \\ k \cdot \cos\left(\frac{3 \cdot kl}{4}\right) & -k \cdot \sin\left(\frac{3 \cdot kl}{4}\right) & \frac{-k}{3} \cdot \sin\left(\frac{kl}{4}\right) \end{pmatrix}$$

$$k \cdot ((\cos(kl) \cdot \cos(0.25 \cdot kl) - 0.33333333 \cdot \sin(kl) \cdot \sin(0.25 \cdot kl)) \cdot \cos(0.75 \cdot kl) + (\sin(kl) \cdot \cos(0.25 \cdot kl) + 0.33333333 \cdot \cos(kl) \cdot \sin(0.25 \cdot kl)) \cdot \sin(0.75 \cdot kl))$$



$$\text{solve}\left(\left(3 \cdot \cos(kl) \cdot \cos\left(\frac{kl}{4}\right) - \sin(kl) \cdot \sin\left(\frac{kl}{4}\right)\right) \cdot \cos\left(\frac{3 \cdot kl}{4}\right) + \left(3 \cdot \sin(kl) \cdot \cos\left(\frac{kl}{4}\right) + \cos(kl) \cdot \sin\left(\frac{kl}{4}\right)\right) \cdot \sin\left(\frac{3 \cdot kl}{4}\right) = 0, kl\right) | kl > 0.001$$

$$kl = 4.1887902 \text{ or } kl = 8.3775804 \text{ or } kl = 16.755161 \text{ or } kl = 16.755161 \text{ or } kl = 20.943951 \text{ or } kl = 20.943951 \text{ or } kl = 29.32153$$



$$\text{tCollect}\left(\left(3 \cdot \cos(kl) \cdot \cos\left(\frac{kl}{4}\right) - \sin(kl) \cdot \sin\left(\frac{kl}{4}\right)\right) \cdot \cos\left(\frac{3 \cdot kl}{4}\right) + \left(3 \cdot \sin(kl) \cdot \cos\left(\frac{kl}{4}\right) + \cos(kl) \cdot \sin\left(\frac{kl}{4}\right)\right) \cdot \sin\left(\frac{3 \cdot kl}{4}\right)\right)$$

$$2 \cdot \cos(0.5 \cdot kl) + 1$$

$$\text{solve}\left(2 \cdot \cos\left(\frac{kl}{2}\right) + 1 = 0, kl\right) | kl > 0.001$$

$$kl = 12.566371 \cdot (n2 - 0.33333333) \text{ and } n2 - 0.33333333 > 0.00007958 \text{ and } n2 \geq 1. \text{ or } kl = 12.566371 \cdot (n2 + 0.33333333) \text{ and } n2 \leq -1$$

$$kl = 12.566371 \cdot (n2 - 0.33333333) | n2 = 0$$

$$kl = -4.1887903$$

$$\text{-----}5$$

$$5$$

$$\text{solve}(kl = 4.1887902, p) | kl = k \cdot l \text{ and } k = \sqrt{\frac{p}{ei}}$$

$$p = \frac{17.545963 \cdot ei}{l^2} \text{ and } \frac{1}{l} \geq 0.$$

$$\text{solve}\left(\frac{17.545963 \cdot ei}{l^2} = \frac{\pi^2 \cdot ei}{(c \cdot l)^2}, c\right)$$

$$c = -0.75000001 \text{ or } c = 0.75000001$$

$$[]$$

