02-21_Slope_Code

February 21, 2023

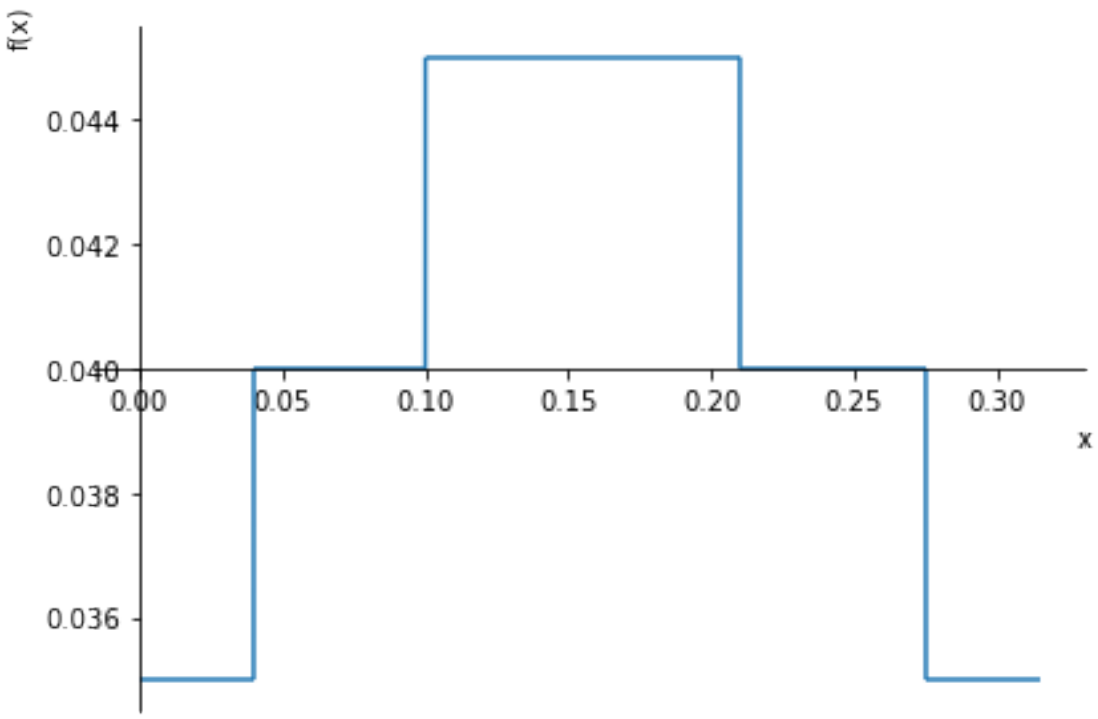
[1]:
```
import sympy as sp
```

[2]:
```
sp.var('x E')
sp.var('y', cls=sp.Function);
```

[3]:
```
d = sp.Piecewise(
  (0.035, x < 0.04),
  (0.04, x < 0.1),
  (0.045, x < 0.21),
  (0.04, x < 0.275),
  (0.035, True),
)
d
```

[3]:
$$\begin{cases} 0.035 & \text{for } x < 0.04 \\ 0.04 & \text{for } x < 0.1 \\ 0.045 & \text{for } x < 0.21 \\ 0.04 & \text{for } x < 0.275 \\ 0.035 & \text{otherwise} \end{cases}$$

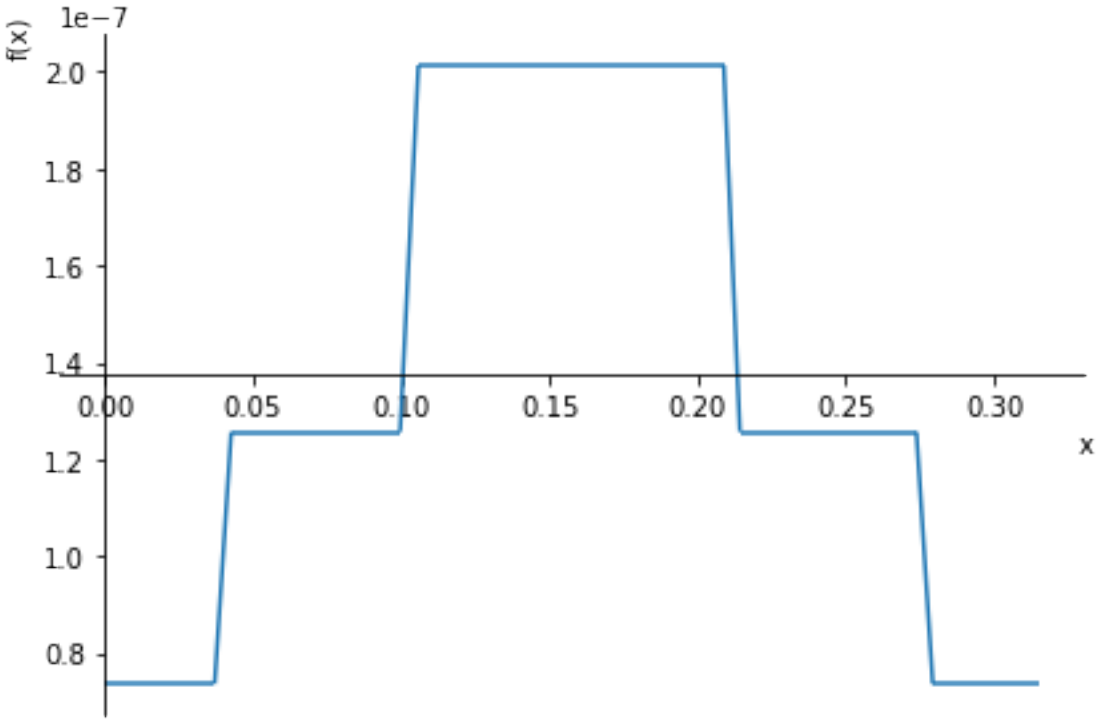
[4]:
```
sp.plot(d, (x, 0, 0.315));
```



[5]:
```
I = sp.pi * d**4 / 64
I
```

[5]:
$$\frac{\pi \begin{cases} 1.500625 \cdot 10^{-6} & \text{for } x < 0.04 \\ 2.56 \cdot 10^{-6} & \text{for } x < 0.1 \\ 4.100625 \cdot 10^{-6} & \text{for } x < 0.21 \\ 2.56 \cdot 10^{-6} & \text{for } x < 0.275 \\ 1.500625 \cdot 10^{-6} & \text{otherwise} \end{cases}}{64}$$

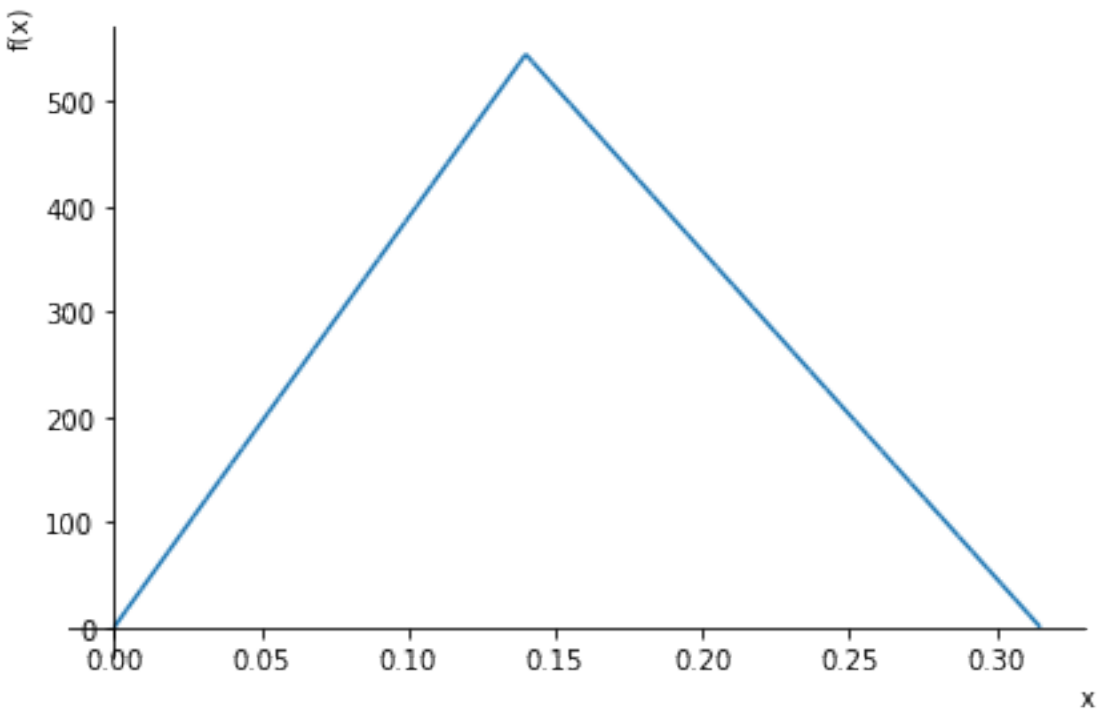
[6]:
```
sp.plot(I, (x, 0, 0.315));
```



[7]:
```
M = sp.Piecewise(
  (3889 * x, x < 0.14),
  (980 - 3111 * x, True),
)
M
```

[7]:
$$\begin{cases} 3889x & \text{for } x < 0.14 \\ 980 - 3111x & \text{otherwise} \end{cases}$$

[8]:
```
sp.plot(M, (x, 0, 0.315));
```



[9]:
```
eqs = [sp.Eq(sp.diff(y(x), x, x), sp.simplify(M / (E * I)))]
sols = sp.dsolve(eqs, func=[y(x)], ics={y(0.0): 0, y(0.315): 0})
eqs[0]
```

[9]:

$$\frac{d^2}{dx^2}y(x) = \begin{cases} \frac{165861557684.298x}{\pi E} & \text{for } x < 0.04 \\ \frac{97225000000.0x}{\pi E} & \text{for } x < 0.1 \\ \frac{60697088858.4057x}{\pi E} & \text{for } x < 0.14 \\ \frac{15295229385.7644 - 48554549611.3397x}{\pi E} & \text{for } x < 0.21 \\ \frac{24500000000.0 - 77775000000.0x}{\pi E} & \text{for } x < 0.275 \\ \frac{41795918367.3469 - 132680716368.18x}{\pi E} & \text{otherwise} \end{cases}$$

[10]:
```
len(sols)
```

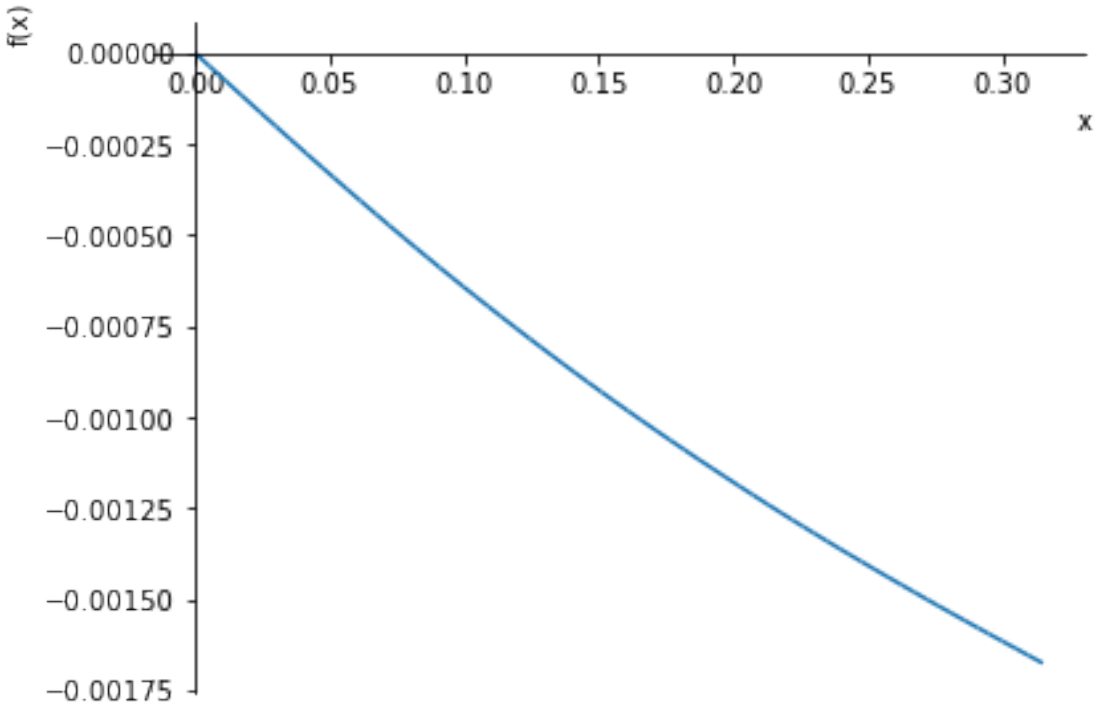
[10]:
```
1
```

[11]:
```
sol = sols[0].simplify()
sol
```

[11]:

$$y(x) = \begin{cases} \frac{x\left(8799228924.79252x^2 - 1396950617.03929\right)}{E} & \text{for } x < 0.04 \\ \frac{1.0\left(5157946447.36984x^3 - 1379472461.14766x - 466084.157110103\right)}{E} & \text{for } x < 0.1 \\ \frac{1.0\left(3220080574.36776x^3 - 1321336484.9576x - 4341815.90311427\right)}{E} & \text{for } x < 0.14 \\ \frac{1.0\left(-2575898860.08179x^3 + 2434311362.46882x^2 - 1662140075.70323x + 11562351.6650154\right)}{E} & \text{for } x < 0.21 \\ \frac{1.0\left(-4126091899.65739x^3 + 3899296105.75144x^2 - 2072343128.74608x + 47455503.3647597\right)}{E} & \text{for } x < 0.275 \\ \frac{1.0\left(-7038930620.98986x^3 + 6652027009.2286x^2 - 2925494840.75622x + 134474892.374797\right)}{E} & \text{otherwise} \end{cases}$$

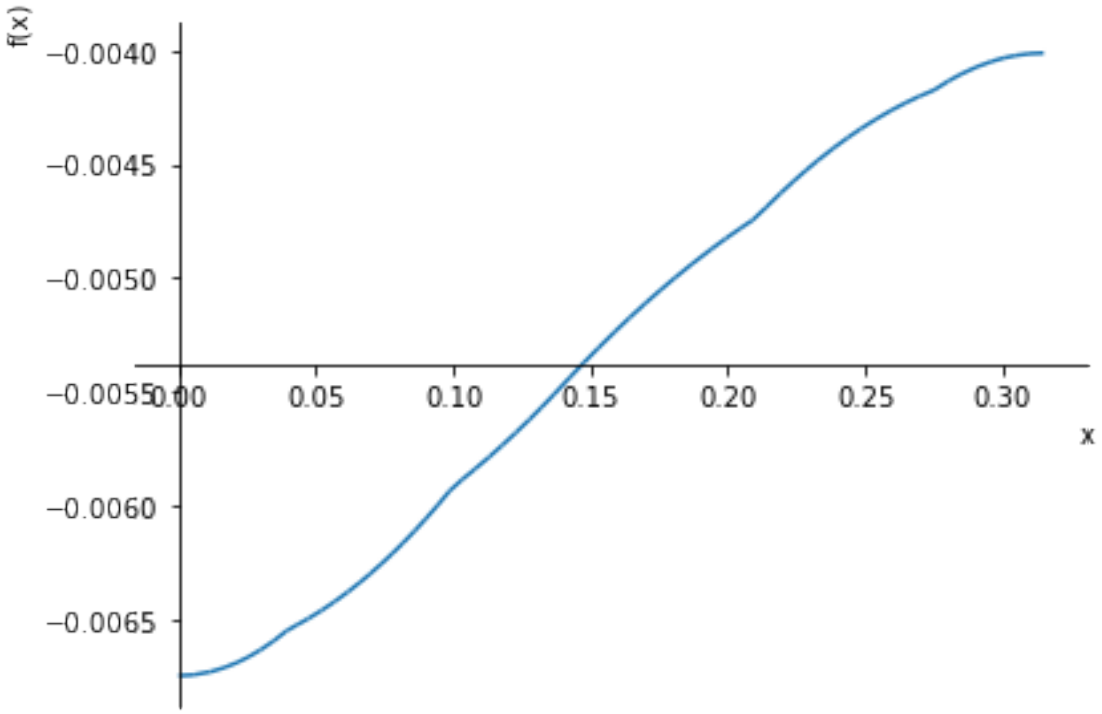
[12]:
```
sp.plot(sol.rhs.subs(E, 207e9), (x, 0, 0.315));
```



[13]:
```
yp = sp.diff(sol.rhs, x)
yp
```

[13]:
$$\begin{cases} \frac{17598457849.585x^2}{E} + \frac{8799228924.79252x^2 - 1396950617.03929}{E} & \text{for } x < 0.04 \\ \frac{1.0\left(15473839342.1095x^2 - 1379472461.14766\right)}{E} & \text{for } x < 0.1 \\ \frac{1.0\left(9660241723.10327x^2 - 1321336484.9576\right)}{E} & \text{for } x < 0.14 \\ \frac{1.0\left(-7727696580.24538x^2 + 4868622724.93764x - 1662140075.70323\right)}{E} & \text{for } x < 0.21 \\ \frac{1.0\left(-12378275698.9722x^2 + 7798592211.50287x - 2072343128.74608\right)}{E} & \text{for } x < 0.275 \\ \frac{1.0\left(-21116791862.9696x^2 + 13304054018.4572x - 2925494840.75622\right)}{E} & \text{otherwise} \end{cases}$$

[14]:
```
sp.plot(yp.subs(E, 207e9), (x, 0, 0.315));
```



[15]:
```
yp.subs(x, 0)
```

[15]:
$$-\frac{1396950617.03929}{E}$$

[16]:
```
yp.subs(x, 0.14)
```

[16]:
$$-\frac{1131995747.18477}{E}$$

[17]:
```
yp.subs(x, 0.315)
```

[17]:
$$-\frac{830031497.545357}{E}$$

[ ]:
```

```