

Exercicio 3 - Placa com 3 componentes

```
from sympy import *
import numpy as np
from scipy.optimize import fsolve
import matplotlib.pyplot as plt
init_printing(pretty_print=True)
```

Entrando com os dados do problema

```
# Geometria
Ly = 0.1 # {m}
Lx = 0.2 # {m}
ep1 = 1.6/1000 # {m}
eco = 0.035 /1000 # {m}
kpl = 8.81 # {W/mk}
kco = 350 #{W/mK}

# Propriedades termicas
Tar = 20 # { o C}
Tpl = 45 # { o C}
h = 10 # {W/m 2 k}

# Propriedades dos componentes eletronicos
Qa = 1 # {W}
Npa = 14 #{pernas}
Lxa = 40 /1000 #{m}
Lya = 20 /1000 #{m}
Dp = 1 /1000 #{m}

Qb = 4 #{W}
Npb = 28 #{pernas}
Lxb = 40 /1000 #{m}
Lyb = 40 /1000 #{m}
Dp = 1 /1000 #{m}

Qc = 0.5 #{W}
Npc= 8 #{pernas}
Lxc = 20 /1000 #{m}
Lyc = 20 /1000 #{m}
Dp = 1 /1000 #{m}

# Propriedades da malha
nx = 10
ny = 5
dx = Lx/nx
dy = Ly/ny
A = dx*dy
Ax = Ay = dx * ep1
Ap = 3.14*Dp*Dp/4
```

Definição das Dissipações "Q"

```
QC2=QC3=Qa/2
QC5=QD5=QC6=QD6=Qb/4
QD9=Qc
```

Definição das condutâncias

```
gc = kp1*A/dx
gcpa = Npa*kco*Ap/dx
gcpb = Npb*kco*Ap/dx
gcpc = Npc*kco*Ap/dx
gcc= 2*gc
gconv = h*A
```

Escrevendo as equações dos nós

```
Temp1 = []
```

```
def Temp1(z):
```

```
    TA1 = z[0]
    TA2 = z[1]
    TA3 = z[2]
    TA4 = z[3]
    TA5 = z[4]
    TA6 = z[5]
    TA7 = z[6]
    TA8 = z[7]
    TA9 = z[8]
    TA10 = z[9]
    TB1 = z[10]
    TB2 = z[11]
    TB3 = z[12]
    TB4 = z[13]
    TB5 = z[14]
    TB6 = z[15]
    TB7 = z[16]
    TB8 = z[17]
    TB9 = z[18]
    TB10 = z[19]
    TC1 = z[20]
    TC2 = z[21]
    TC3 = z[22]
    TC4 = z[23]
    TC5 = z[24]
    TC6 = z[25]
    TC7 = z[26]
    TC8 = z[27]
    TC9 = z[28]
    TC10 = z[29]
```

```

TD1 = z[30]
TD2 = z[31]
TD3 = z[32]
TD4 = z[33]
TD5 = z[34]
TD6 = z[35]
TD7 = z[36]
TD8 = z[37]
TD9 = z[38]
TD10 = z[39]
TE1 = z[40]
TE2 = z[41]
TE3 = z[42]
TE4 = z[43]
TE5 = z[44]
TE6 = z[45]
TE7 = z[46]
TE8 = z[47]
TE9 = z[48]
TE10 = z[49]

```

```
F = np.empty((50))
```

```
# Equacoes dos nos
```

```

F[0] = gc*(TA2-TA1) + gc*(TB1-TA1) + gcc*(Tp1-TA1) + gconv*(Tar -TA1)
F[1] = gc*(TA1-TA2) + gc*(TA3-TA2) + gc*(TB2-TA2) + gcc*(Tp1-TA2) + gconv*(Tar-TA2)
F[2] = gc*(TA2-TA3) + gc*(TA4-TA3) + gc*(TB3-TA3) + gcc*(Tp1-TA3) + gconv*(Tar-TA3)
F[3] = gc*(TA3-TA4) + gc*(TA5-TA4) + gc*(TB3-TA3) + gcc*(Tp1-TA3) + gconv*(Tar-TA3)
F[4] = gc*(TA4-TA5) + gc*(TA6-TA5) + gc*(TB5-TA5) + gcc*(Tp1-TA5) + gconv*(Tar-TA5)
F[5] = gc*(TA5-TA6) + gc*(TA7-TA6) + gc*(TB6-TA6) + gcc*(Tp1-TA6) + gconv*(Tar-TA6)
F[6] = gc*(TA6-TA7) + gc*(TA8-TA7) + gc*(TB7-TA7) + gcc*(Tp1-TA7) + gconv*(Tar-TA7)
F[7] = gc*(TA7-TA8) + gc*(TA9-TA8) + gc*(TB8-TA8) + gcc*(Tp1-TA8) + gconv*(Tar-TA8)
F[8] = gc*(TA8-TA9) + gc*(TA10-TA9) + gc*(TB9-TA9) + gcc*(Tp1-TA9) + gconv*(Tar-TA9)
F[9] = gc*(TA9-TA10) + gc*(TB10-TA10) + gcc*(Tp1-TA10) + gconv*(Tar-TA10) + gconv*(Tar-T
F[10] = gc*(TA1-TB1) + gc*(TB2-TB1) + gc*(TC1-TB1) + gconv*(Tar-TB1)
F[11] = gc*(TB1-TB2) + gc*(TB3-TB2) + gc*(TA2-TB2) + gc*(TC2-TB2) + gconv*(Tar-TB2)
F[12] = gc*(TB2-TB3) + gc*(TB4-TB3) + gc*(TA3-TB3) + gc*(TC3-TB3) + gconv*(Tar-TB3)
F[13] = gc*(TB3-TB4) + gc*(TB5-TB4) + gc*(TA4-TB4) + gc*(TC4-TB4) + gconv*(Tar-TB4)
F[14] = gc*(TB4-TB5) + gc*(TB6-TB5) + gc*(TA5-TB5) + gc*(TC5-TB5) + gconv*(Tar-TB5)
F[15] = gc*(TB5-TB6) + gc*(TB7-TB6) + gc*(TA6-TB6) + gc*(TC6-TB6) + gconv*(Tar-TB6)
F[16] = gc*(TB6-TB7) + gc*(TB8-TB7) + gc*(TA7-TB7) + gc*(TC7-TB7) + gconv*(Tar-TB7)
F[17] = gc*(TB7-TB8) + gc*(TB9-TB8) + gc*(TA8-TB8) + gc*(TC8-TB8) + gconv*(Tar-TB8)
F[18] = gc*(TB8-TB9) + gc*(TB10-TB9) + gc*(TA9-TB9) + gc*(TC9-TB9) + gconv*(Tar-TB9)
F[19] = gc*(TA10-TB10) + gc*(TB9-TB10) + gc*(TC10-TB10) + gconv*(Tar-TB10)
F[20] = gc*(TB1-TC1) + gc*(TC2-TC1) + gc*(TD1-TC1) + gconv*(Tar-TC1)
F[21] = gc*(TC1-TC2) + gc*(TC3-TC2) + gc*(TB2-TC2) + gc*(TD2-TC2) + gconv*(Tar-TC2) + gc
F[22] = gc*(TC2-TC3) + gc*(TC4-TC3) + gc*(TB3-TC3) + gc*(TD3-TC3) + gconv*(Tar-TC3) + gc
F[23] = gc*(TC3-TC4) + gc*(TC5-TC4) + gc*(TB4-TC4) + gc*(TD4-TC4) + gconv*(Tar-TC4)
F[24] = gc*(TC4-TC5) + gc*(TC6-TC5) + gc*(TB5-TC5) + gc*(TD5-TC5) + gconv*(Tar-TC5) + gc
F[25] = gc*(TC5-TC6) + gc*(TC7-TC7) + gc*(TB6-TC6) + gc*(TD6-TC6) + gconv*(Tar-TC6) + gc
F[26] = gc*(TC6-TC7) + gc*(TC8-TC7) + gc*(TB7-TC7) + gc*(TD7-TC7) + gconv*(Tar-TC7)
F[27] = gc*(TC7-TC8) + gc*(TC9-TC8) + gc*(TB8-TC8) + gc*(TD8-TC8) + gconv*(Tar-TC8)
F[28] = gc*(TC8-TC9) + gc*(TC10-TC9) + gc*(TB9-TC9) + gc*(TD9-TC9) + gconv*(Tar-TC9)
F[29] = gc*(TB10-TC10) + gc*(TC9-TC10) + gc*(TD10-TC10) + gconv*(Tar-TC10)

```


T 2 C = 44.970156021367764
T 3 C = 45.019577740757796
T 4 C = 45.06577639615445
T 5 C = 45.10875198755772
T 6 C = 45.101111629876584
T 7 C = 45.013284451838544
T 8 C = 44.932036111259244
T 9 C = 44.8695770723349
T 10 C = 44.77881177872868
T 1 D = 44.914944464216426
T 2 D = 44.970156021367764
T 3 D = 45.019577740757796
T 4 D = 45.06577639615445
T 5 D = 45.10875198755772
T 6 D = 45.101111629876584
T 7 D = 45.013284451838544
T 8 D = 44.932036111259244
T 9 D = 44.8695770723349
T 10 D = 44.77881177872868
T 1 E = 44.914944464216426
T 2 E = 44.970156021367764
T 3 E = 45.019577740757796
T 4 E = 45.06577639615445
T 5 E = 45.10875198755772
T 6 E = 45.101111629876584
T 7 E = 45.013284451838544
T 8 E = 44.932036111259244
T 9 E = 44.8695770723349
T 10 E = 44.77881177872868

✓ 0s conclusão: 15:12

