

>

```
sys := {diff(cm(x, t), t) = Dm * diff(cm(x, t), x, x) - Vm * diff(cm(x, t), x) - pm * (cm(x, t)
- cim(x, t)), diff(cim(x, t), t) = pim * (cm(x, t) - cim(x, t))}:
param1 := {Vm = 100, t0 = 0.0104167, a = 5800, L = 80};
conds := {cm(0, t) - Dm/Vm * D[1](cm)(0, t) = piecewise(t < t0, a, 0), cm(L, t) + Dm
/ Dm * D[1](cm)(L, t) = 0, cm(x, 0) = 0, cim(x, 0) = 0}:
PDE := proc(p, pi, d) local param, res, RES, CM, CIM;
param := param1 union {pm = p, pim = pi, Dm = d};
res := pdsolve(eval(sys, param), eval(conds, param), numeric, time = t, range = 0..80,
timestep = 1e-4);
RES := res:-value([cm(x, t), cim(x, t)], output = listprocedure);
CM, CIM := op(map2(subs, RES, [cm(x, t), cim(x, t)]));
proc(tt) local CMx; CMx := fdiff(CM, [1], [40, tt]); eval(CM(40, tt) - Dm/Vm
* CMx(tt), param) end proc;
end proc;
```

```
pkt := [[0.109999999, 18.41229218], [0.119999997, 0.680997417], [0.150000006,
11.34341156], [0.180000007, 9.611664101], [0.239999995, 32.06525044],
[0.270000011, 23.47376256], [0.300000012, 29.52019663], [0.330000013,
30.67924912], [0.360000014, 35.37349667], [0.389999986, 35.11763097],
[0.419999987, 32.14860584], [0.449999988, 35.41756096], [0.479999989,
34.9604712], [0.50999999, 37.68844646], [0.540000021, 41.88497296],
[0.569999993, 39.64117882], [0.600000024, 42.05535303], [0.629999995,
39.94486929], [0.660000026, 44.59854681], [0.689999998, 47.19501527],
[0.720000029, 46.26115388], [0.75, 39.10707625], [0.779999971, 41.88047715],
[0.810000002, 42.16466141], [0.839999974, 39.49714509], [0.870000005,
39.48734281], [0.899999976, 37.97310573], [0.930000007, 39.92745121],
[0.959999979, 40.06443447], [0.990000001, 38.4813858], [1.019999981,
39.14978735], [1.049999952, 39.8899591], [1.080000043, 38.62397031],
[1.110000014, 35.39244818], [1.139999986, 31.88178061], [1.169999957,
31.71301782], [1.200000048, 33.69222106], [1.230000019, 36.34166974],
[1.25999999, 30.04083752], [1.289999962, 30.38267207], [1.320000052,
30.1420508], [1.350000024, 28.60564902], [1.379999995, 31.09323852],
[1.409999967, 29.30393983], [1.440000057, 28.10198185], [1.470000029,
24.11459137], [1.5, 22.21617043], [1.529999971, 24.1371621], [1.559999943,
18.712847], [1.590000033, 15.15661141], [1.620000005, 21.5779102],
[1.649999976, 21.87426319], [1.679999948, 21.01609659], [1.710000038,
19.52179611], [1.74000001, 21.74888248], [1.769999981, 20.47264971],
[1.799999952, 19.19233936], [1.830000043, 17.81771977], [1.860000014,
17.12563454], [1.889999986, 18.6200825], [1.919999957, 18.02911826],
[1.950000048, 17.6074573], [1.980000019, 17.61900188], [2.00999999,
16.19762584], [2.039999962, 13.97954231], [2.069999933, 15.67367544],
[2.099999905, 11.69162856], [2.130000114, 11.73456908], [2.160000086,
10.76488136], [2.190000057, 10.45784273], [2.220000029, 11.59624468], [2.25,
10.76479509], [2.279999971, 8.871161313], [2.309999943, 9.570999807],
[2.339999914, 7.685936632], [2.369999886, 7.575811132], [2.400000095,
6.652440192], [2.430000067, 6.462728244], [2.460000038, 6.434803064],
[2.49000001, 6.619340902]];
```

```
F := proc(p, pi, d) local H; H := PDE(p, pi, d); add((H(pkt[k, 1]) - pkt[k, 2])^2, k = 1
..80) end proc;
```

#Now using Sergey Moiseev's package DirectSearch (available from the Maple Application Center:

with(DirectSearch) :

Search(F, initialpoint = [1, 1, 100], tolerances = .001);

param1 := {L = 80, Vm = 100, a = 5800, t0 = 0.0104167}

```
pkt := [[0.109999999, 18.41229218], [0.119999997, 0.680997417], [0.150000006,
11.34341156], [0.180000007, 9.611664101], [0.239999995, 32.06525044],
[0.270000011, 23.47376256], [0.300000012, 29.52019663], [0.330000013,
30.67924912], [0.360000014, 35.37349667], [0.389999986, 35.11763097],
[0.419999987, 32.14860584], [0.449999988, 35.41756096], [0.479999989,
34.9604712], [0.50999999, 37.68844646], [0.540000021, 41.88497296],
[0.569999993, 39.64117882], [0.600000024, 42.05535303], [0.629999995,
39.94486929], [0.660000026, 44.59854681], [0.689999998, 47.19501527],
[0.720000029, 46.26115388], [0.75, 39.10707625], [0.779999971, 41.88047715],
[0.810000002, 42.16466141], [0.839999974, 39.49714509], [0.870000005,
39.48734281], [0.899999976, 37.97310573], [0.930000007, 39.92745121],
[0.959999979, 40.06443447], [0.990000001, 38.4813858], [1.019999981,
39.14978735], [1.049999952, 39.8899591], [1.080000043, 38.62397031],
[1.110000014, 35.39244818], [1.139999986, 31.88178061], [1.169999957,
31.71301782], [1.200000048, 33.69222106], [1.230000019, 36.34166974],
[1.25999999, 30.04083752], [1.289999962, 30.38267207], [1.320000052,
30.1420508], [1.350000024, 28.60564902], [1.379999995, 31.09323852],
[1.409999967, 29.30393983], [1.440000057, 28.10198185], [1.470000029,
24.11459137], [1.5, 22.21617043], [1.529999971, 24.1371621], [1.559999943,
18.712847], [1.590000033, 15.15661141], [1.620000005, 21.5779102],
[1.649999976, 21.87426319], [1.679999948, 21.01609659], [1.710000038,
19.52179611], [1.740000001, 21.74888248], [1.769999981, 20.47264971],
[1.799999952, 19.19233936], [1.830000043, 17.81771977], [1.860000014,
17.12563454], [1.889999986, 18.6200825], [1.919999957, 18.02911826],
[1.950000048, 17.6074573], [1.980000019, 17.61900188], [2.00999999,
16.19762584], [2.039999962, 13.97954231], [2.069999933, 15.67367544],
[2.099999905, 11.69162856], [2.130000114, 11.73456908], [2.160000086,
10.76488136], [2.190000057, 10.45784273], [2.220000029, 11.59624468], [2.25,
10.76479509], [2.279999971, 8.871161313], [2.309999943, 9.570999807],
[2.339999914, 7.685936632], [2.369999886, 7.575811132], [2.400000095,
6.652440192], [2.430000067, 6.462728244], [2.460000038, 6.434803064],
[2.490000001, 6.619340902]]
```

$$\left[ 973.396518313354, \begin{bmatrix} 10.6246249626560002 \\ 5.70557785663550998 \\ 325.415930154068974 \end{bmatrix}, 460 \right] \quad (1)$$

$$pkt_{1,1} \quad (2)$$