```python
1  # Groundwater Modeling Coding Assignment #2
2  # Jim Finnegan
3  # 1D Transport Equation
4  # Analytical Solution
5
6  import numpy as np
7  from math import exp, sqrt
8  from scipy.special import erfc
9  from matplotlib import pyplot as plt
10
11 # initial conditions
12 # for R = 1
13 v = 0.1
14 D = int(input('Enter D (m^2/d): '))
15 L, dx = 200, 2
16 dist = np.linspace(2, L, num=int(L/dx))
17 dist = [int(x) for x in dist]
18 # print(dist)
19 t, dt = 400, 10
20 time = np.linspace(10, t, num=int(t/dt))
21 time = [int(t) for t in time]
22 # print(time)
23
24 # initialize grid for C
25 # x is distance (one column is 2 ft), y is time (one row is 10 days)
26 C = np.zeros((len(time)+1, len(dist)+1))
27 C[:, 0] = 1      # boundary condition: C/C0 = 1 at x=0
28
29 # calculate C using analytical solution for all x>0
30 for x in range(len(dist)):
31     for t in range(len(time)):
32         C[t+1][x+1] = (1/2)*(exp(v*dist[x]/D)*erfc((dist[x]+v*time[t
   ])/(2*sqrt(D*time[t])))+erfc((dist[x]-v*time[t])/(2*sqrt(D*time[t
   ]))))
33
34 # plot
35 dist.insert(0, 0)
36 plt.plot(dist, C[0, :])
37 plt.plot(dist, C[10, :])
38 plt.plot(dist, C[20, :])
39 plt.plot(dist, C[30, :])
40 plt.plot(dist, C[40, :])
41
42 plt.title('Analytical Solution')
43 plt.xlabel('distance (m)')
44 plt.ylabel('C/C0')
45 plt.legend(['0 days', '100 days', '200 days', '300 days', '400 days'
   ])
46 plt.show()
47
```