

In [2]:

```
# packages
import numpy as np
from scipy import linalg
import scipy
from scipy import integrate
import matplotlib.pyplot as plt
```

## 1.1

In [12]:

```
# Define the function
def Without_buffer(N1, N2, t):
    k12 = 105/740
    k21 = 102/900
    gamma = 347
    dN1dt = -k12 * N1 + k21 * N2 + gamma
    dN2dt = k12 * N1 - k21 * N2
    return [dN1dt, dN2dt]

# Initial condition
Ni = [740, 900]

# Time points
t = np.linspace(1985, 2022, 38)

# Solve ODE
f1 = integrate.odeint(Without_buffer, Ni, t)

plt.plot(t, f1)
```

## 1.2

In [1]:

```
# Define the function
def With_buffer(N1, N2, N20, t):
    k12 = 105/740
    k21 = 102/900
    gamma = 347
    kesai = ((P-290.21)/290.21) / ((C-2.057*1e-3)/2.057*1e-3)
    dN1dt = -k12 * N1 + k21 * (N20 + kesai*(N2 - N20)) + gamma
    dN2dt = k12 * N1 - k21 * (N20 + kesai*(N2 - N20))
    return [dN1dt, dN2dt]

# Initial condition
Ni = [740,900]

# Time points
t = np.linspace(1985,2022,38)

# Solve ODE
f2 = integrate.odeint(With_buffer, Ni, t)

plt.plot(t,f2)
```

## 1.3

In [ ]:

```
plt.plot(t, f1, f2, 'k-', 'o-', linewidth = 2)
```