In [3]:
```
import matplotlib.pyplot as plt
import numpy as np
import math

# Radioactive decay of Thorium Isotope-234
# Here we will solve the differential equation
# dQ/dt=-rQ,  r = 0.02828 days-1, q(0)=100 mg. t is in days
# Example is taken from the book:  Elementary Differential Equations and
# Boundary Value Problems.By William E. Boyce and Richard D. Prima. page 44.
# The exact solution can be found to be:  Q(t)=100*exp(-rt)
# The Euler method is implemented to find the numerical solution
# of the differential equation.
# The objective is to study the effect of the timestep but also use
# the simulation to determine the half life
# of the isotope (halveringstiden)


dt = 5  # days
tstart = 0
tend  = 50 # days
r = 0.02828  # days-1

T=[]
Qexact=[]
Qeuler=[]

# Save the initial condition y(0)=1 in the arrays

t = tstart
qexact = 100 # mg
qeuler = 100 # mg

T.append(t)
Qexact.append(qexact)
Qeuler.append(qeuler)

while (t<tend):
    dt = min(dt,tend-t)
    qeuler =qeuler+dt*(-r*qeuler)
    t = t+dt
    qexact= 100*math.exp(-r*t)

    T.append(t)
    Qexact.append(qexact)
    Qeuler.append(qeuler)

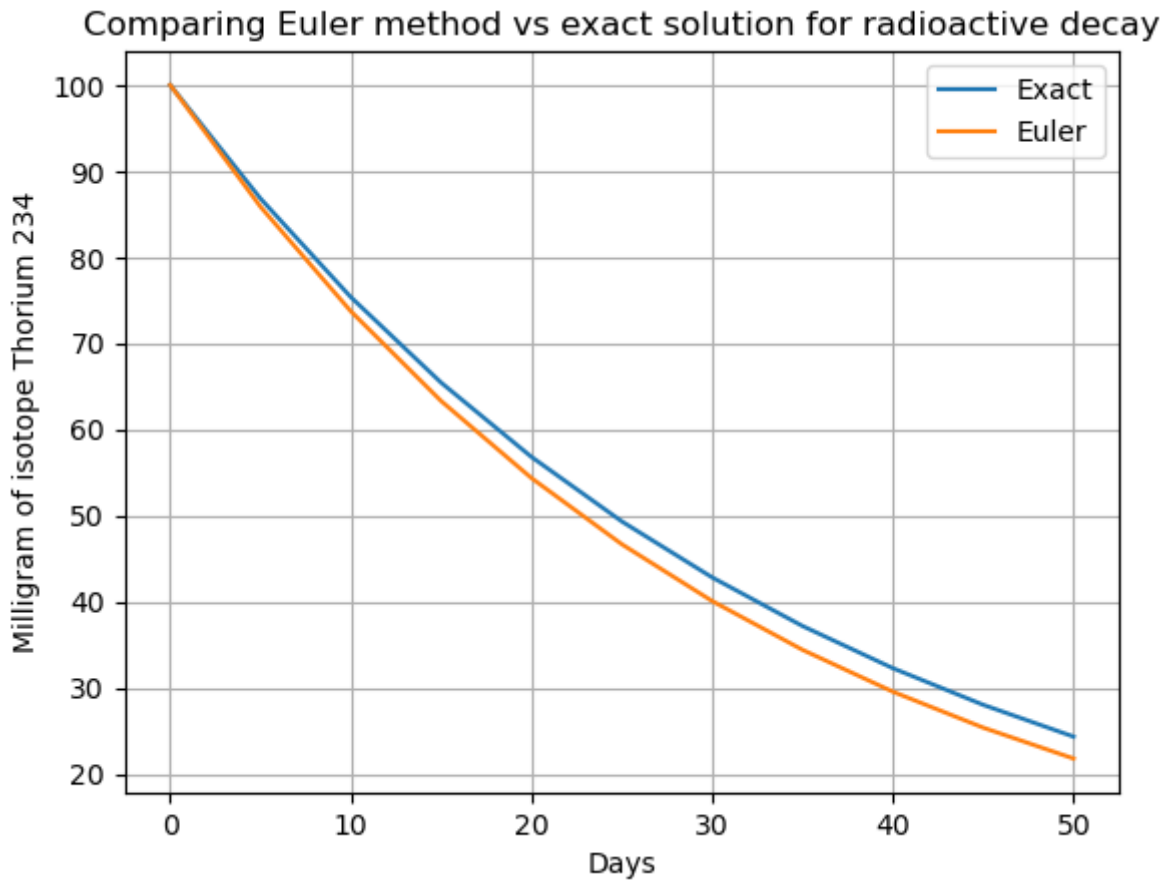


plt.plot(T,Qexact,T,Qeuler)
plt.title('Comparing Euler method vs exact solution for radioactive decay')
plt.grid(True)
plt.xlabel('Days')
plt.ylabel('Milligram of isotope Thorium 234')
plt.legend(['Exact', 'Euler'])
plt.show()

print('Start with dt = 5 days (step size) and then reduce the timestep until'
     ' you think that the numerical solution has converged to the exact solution')

print('-----------------------------------------------------------------------')
```

```
print('From the graphs, try to estimate the half life of the  Thorium Isotope.'
      'Then try to find the exact '
      'half life time using the expression for the exact solution')
```




```
Start with dt = 5 days (step size) and then reduce the timestep until you think th
at the numerical solution has converged to the exact solution
------------------------------------------------------------------------
From the graphs, try to estimate the half life of the  Thorium Isotope.Then try to
find the exact half life time using the expression for the exact solution
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In [ ]:

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