Obligatoriske oppgaven TMA4101

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1 Newtons avkjølingslov

$$\frac{d}{dt}T = \alpha \cdot (T(t) - T_k) \qquad T(0) = T_0 \tag{1}$$

2 Utstyr

- Kanelbolle fra IKEA
- Termometer
- Tålmodighet

3 Fremgangsmåte

1. Start med å skru på ovnen
2. Sett bollen inn når temperaturen i ovnen er tilstrekkelig høy
3. Ta bollen ut når den er ferdig stekt
4. Noter ned tid og temperatur til bollen frem til den har nådd samme temperatur som omgivelsene.
5. Regne ut α basert på målingene og plotte den teoretiske grafen mot grafen til de målte verdiene

4 Resultat

4.1 Regne ut α

Brukte verdien for temperaturen etter at det har gått 20 min. Altså t = 20, da var T(20)=50.0

$$\begin{aligned} T(20) = 21.0 + 69.5 \cdot e^{-\alpha \cdot 10} &= 50.0 \\ 69.5 \cdot e^{-\alpha \cdot 10} &= 29.0 \\ e^{-20 \cdot \alpha} &= \frac{29.0}{69.5} \\ e^{-20 \cdot \alpha} &= 0.417 \\ ln(e^{-20 \cdot \alpha}) &= ln(0.417) \\ -20 \cdot \alpha &= -0.874 \\ \alpha &= 0.0437 \end{aligned} \tag{2}$$

4.2 Koden:

```
import numpy as np
import matplotlib.pyplot as plt

T_null = 90.5
T_k = 21.0
a = 0.0437

def T(t):
    return T_k+(T_null-T_k)*(np.e**(-a*t))

t = np.linspace(0,150,100)
T_verdier = T(t)

tid =[0.167,0.33,0.5,0.66,0.83,1, 1.167,1.33,1.5,1.66,1.83,2,
2.167,2.33,2.5,2.66,2.83,3,3.167,3.33,3.5,3.66,
4,4.167,4.33,4.5,4.66,4.83,5,5.167,5.33,5.5,5.66,5.83,
6,6.167,6.33,6.5,6.66,6.83,7,7.167,7.33,7.5,7.66,7.83,
8,8.167,8.33,8.5,8.66,8.83,9,9.167,9.33,9.5,9.66,9.83,
10,10.167,10.33,10.5,10.66,10.83,11,11.167,11.33,11.5,11.66,11.83,
12,12.167,12.33,12.5,12.66,12.83,13,13.167,13.33,13.5,13.66,13.83,
14,14.167,14.33,14.5,14.66,14.83,15,15.167,15.33,15.5,15.66,15.83,
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24,24.167,24.33,24.5,24.66,24.83,25,25.5,26,26.5,27,27.5,28,28.5,
29,29.5,30,30.5,31,31.5,32,32.5,33,34,35,36,37,38,39,40,41,42,43,
44,45,47,49,51,54,57,60,63,66,69,74,79,84,89,94,99,104,109,118,140]
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```
temperatur=[90.5,90.1,89.3,88.5,87.3,86.1,84.9,84.1,83.7,84.9,84.5,
83.7,82.9,82.1,81.3,80.9,80.5,83.3,82.5,81.7,81.3,80.5,79.7,79.3,
78.9,78.5,77.7,77.3,76.9,76.5,76.1,75.7,75.3,74.9,74.5,73.7,74.1,
73.7,73.3,72.9,72.5,72.1,71.7,71.3,70.5,70.1,69.1,69.3,68.9,68.5,
68.1,67.7,66.9,66.9,66.5,66.1,65.7,65.3,64.9,64.5,64.1,63.7,63.3,
62.9,62.5,62.1,62.1,61.7,61.3,61.3,60.9,60.5,60.1,60.1,59.7,59.3,
58.9,58.5,58.5,58.1,57.7,57.7,57.3,56.9,56.9,56.5,56.5,56.1,55.7,
55.7,55.3,55.3,54.9,54.9,54.5,54.1,54.1,53.7,53.3,53.3,52.9,52.9,
52.5,52.5,52.1,52.1,51.7,51.7,51.3,51.3,50.9,50.9,50.8,50.8,50.8,
50.4,50.4,50.4,50.0,49.6,49.6,49.2,49.2,49.2,48.8,48.4,48.4,48.4,
48.0,48.0,47.6,47.6,47.2,47.2,46.8,46.8,46.4,46.4,46.4,46.0,46.0,
46.0,45.6,45.6,45.2,45.2,45.2,44.8,44.8,44.4,44.0,43.2,42.8,42.4,
42.0,41.6,41.2,40.8,40.8,40.4,40.0,39.6,39.2,38.8,38.4,38.0,37.2,
36.8,36.4,35.6,35.2,34.7,34.3,33.9,33.5,33.1,32.7,31.9,31.1,30.6,29.8,
28.6,27.8,27.3,26.5,26.1,25.2,24.8,24.0,23.6,22.9,22.5,22.0,21.6,21.0,21.0]

fig,ax = plt.subplots()
ax.plot(t, T_verdier,label="teoretiske")
ax.plot(tid, temperatur,label="maalte")
ax.legend()
ax.set_ylabel("tid,min")
ax.set_xlabel("temperatur, C")
plt.savefig("Obligoppgaven_newtonsavkjolingslov")
plt.show()
```

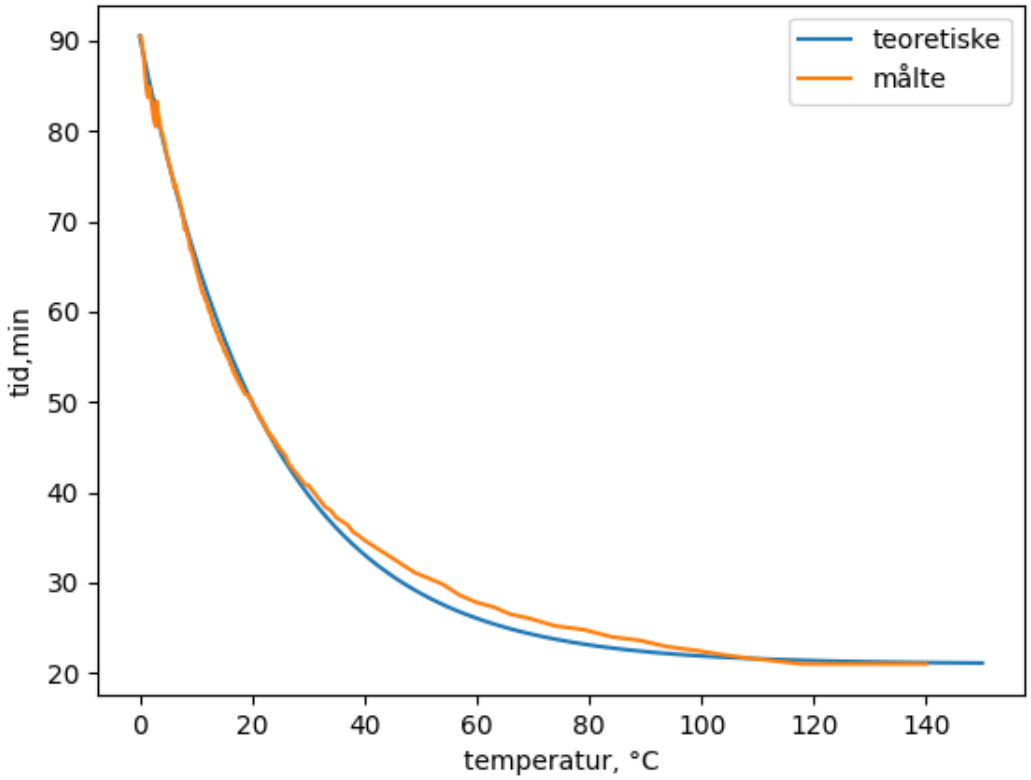

Figure 1:

5 Konklusjon

Som vi kan se avviker de målte dataene fra den teoretiske. Det kan være mange forklaringer på hvorfor, for eksempel unøyaktig måleutstyr og målinger. Også at temperaturen i rommet også kan ha endret seg underveis.