# Project 1

## Problem 1

### a)

We have a object drop from a high, subjected to the forces of gravity and friction du to air resistant. The air resistant can have to states dependig on the state of the parachute. Ther air resistant are 7 times higher with the parachute open. Assuming the gravity are fairly constant at 9.81 m/s^2 at the drop high to the ground. The parachut open at T(min) and the air resitant have a constant described by b. The hight have the constant y.

First we set the constants

https://www.fallskjerm.no/nb/tandemhopp/

The b constant for air resistant are a proximaty based on the output, however a fuction for calcuating the air resistand based on the speed squared was found.

```
syms Fd Cd Ad rho v

Fd = Cd*Ad*rho*v^2
```

Fd = $\mathrm{Ad}\,\mathrm{Cd}\,\rho\, v^2$

Cd is 1, Ad is 1.9, rho 1.225,

```
bbs = 1*1.9*1.225
```

```
bbs = 2.3275
```

This gives a air resistance of 2.4. This is however based on the speed squared. To compensat 10 was used as a proximity as this worked well with the calculations. A more exact number could be calcuated based on the terminal speed of a human body. This would however change based on the altitude and the proximity of 10 seems reasonable.

> Vi hopper fra fly og utsprangshøyde er normalt **12.500 fot eller ca. 4000 meter**.
> er 40-45 sekunder i ca. 200 km/t.

```
mS = 80;        % Weight oif the man in kg
bS = 10;        % Air resistant constant
hS = 4000;      % Drop height
g = 9.81;       % Acceleration due to gravity
```

Force due to gravity:

Fg = m*g

Force due to air resistant:

t<T :     Ff = y'*b

t>=T :     Ff = y'*7b

Drop hight;

y(0) = h

Equation:

ma = Ff - Fg

a = (Ff-Fg)/m

y''=(y'*b - m * g)/m

y'' = y'*(b/m) - g

```
syms y(t) b m

dy = diff(y);

% Differential equation
ode = diff(y,t,2) == - diff(y,t)*(b/m) - g
```

ode(t) =

$$\frac{\partial^2}{\partial t^2}\ y(t) = -\frac{b\,\frac{\partial}{\partial t}\ y(t)}{m} - \frac{981}{100}$$

```
ode2 = diff(y,t,2) == - diff(y,t)*(7*b/m) - g
```

ode2(t) =

$$\frac{\partial^2}{\partial t^2}\ y(t) = -\frac{7\,b\,\frac{\partial}{\partial t}\ y(t)}{m} - \frac{981}{100}$$

```
% Condition
cond = [y(0) == hS dy(0) == 0];
T = 45;

% First part
```

```
ySolve(t) = dsolve(ode, cond)
```

ySolve(t) =

$$\frac{400000\,b^2+981\,m^2}{100\,b^2}-\frac{981\,m\,t}{100\,b}-\frac{981\,m^2\,e^{-\frac{b\,t}{m}}}{100\,b^2}$$

```
yEnd(t) = subs(ySolve, {b m}, {bS mS})
```

yEnd(t) =

$$\frac{115696}{25}-\frac{15696\,e^{-\frac{t}{8}}}{25}-\frac{1962\,t}{25}$$

```
Dy = diff(yEnd);
% New conditions
cond2 = [y(T) == yEnd(T) dy(T) == Dy(T)]
```

cond2 =

$$\left(y(45)=\frac{27406}{25}-\frac{15696\,e^{-\frac{45}{8}}}{25} \quad \left(\left(\frac{\partial}{\partial t}\,y(t)\right)\Big|_{t=45}\right)=\frac{1962\,e^{-\frac{45}{8}}}{25}-\frac{1962}{25}\right)$$

```
% Second part
ySolve2(t) = dsolve(ode2, cond2)
```

ySolve2(t) =

$$\frac{e^{-\frac{45}{8}}\,(54936\,b\,m+5371576\,b^2\,e^{45/8}+981\,m^2\,e^{45/8}-3076416\,b^2+254079\,b\,m\,e^{45/8})}{4900\,b^2}-\frac{981\,m\,t}{700\,b}-\frac{981\,e^{-\frac{45}{8}}\,e}{}$$

```
yEnd2(t) = subs(ySolve2, {b m}, {bS mS})
```

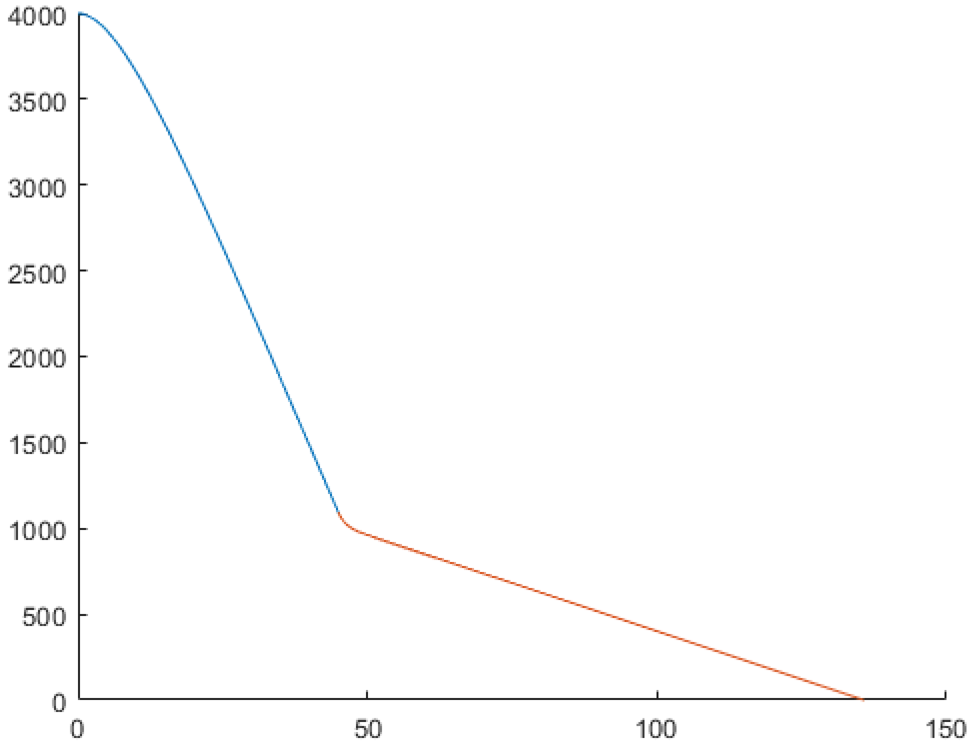
yEnd2(t) =

$$\frac{e^{-\frac{45}{8}}\,(746699200\,e^{45/8}-263692800)}{490000}-\frac{1962\,t}{175}+\frac{981\,e^{-\frac{7\,t}{8}}\,e^{135/4}\,(38400\,e^{45/8}-44800)}{490000}$$

```
% Solve for ground hit
hitT = vpasolve(yEnd2 == 0, t,[0 inf])
```

hitT = $135.74853925809801062432001733385$

```
% Plot graph
hold on
ylim([0 hS])
fplot(yEnd,[0 T])
fplot(yEnd2,[T 150])
```



4000
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150