MATLAB, Lab 6 – Individual work

1. Open the file Lab6_1.m, waterheight.m. Change them in such a way, that values of constants Q, S, Sh, g are defined in Lab6_1.m. Paste the code of Lab6_1.m.m.

Code:

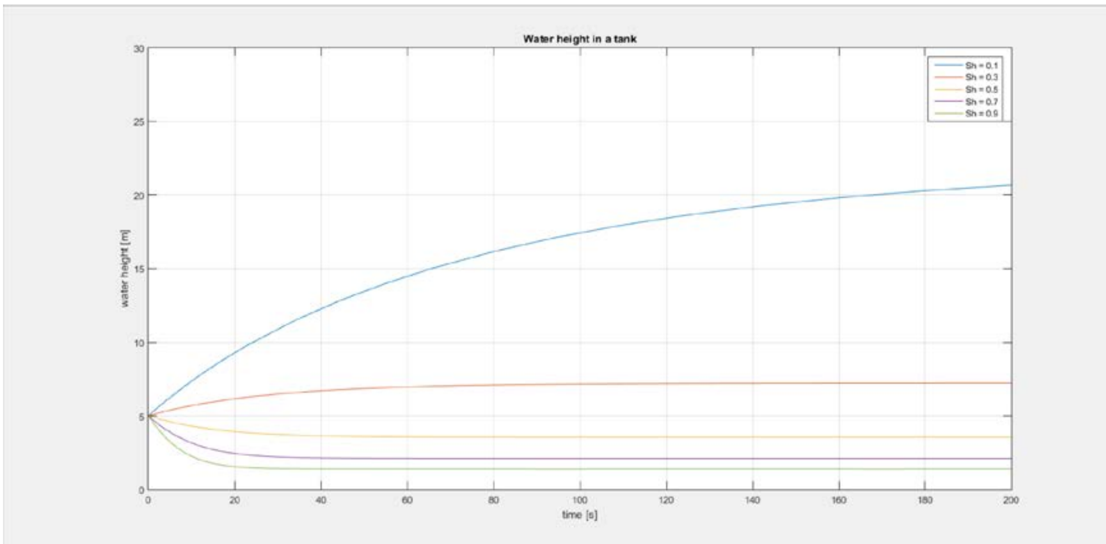
```
h0=5;
Q=5;      % Inflow volutemtric flow rate [m^3 s^(-1)]
S=5;      % Cross section area of the tank [m^3]
Sh=0.64;  % Hole area [m^3]
g=9.81;   % Gravitational acceleration [m s^(-2)]

[T, H]=ode45(@waterheight, [0 2000], h0 , [], Q , S , Sh , g );

plot (T,H)
grid on;
xlabel('time [s]')
ylabel('water height [m]')
title('Water height in a tank')


function dh=waterheight(t,h,Q,S,Sh,g)

dh=Q/S-0.6*Sh/S*sqrt(2*g*h);
```

2. Inspect influence of factor Sh on the solution. This can be done by repetitive use of ode45 with different values of input values (f. eg. with loop “for”). Analyze 5 different cases and put them together on one plot with proper legend and axis labels. Paste the code and screenshot.

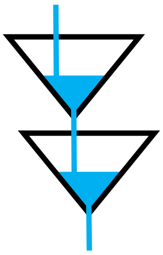
Code:

```
h0=5;
Q=5;      % Inflow volutemtric flow rate [m^3 s^(-1)]
S=5;      % Cross section area of the tank [m^3]
g=9.81;   % Gravitational acceleration [m s^(-2)]

for Sh =0.1:0.2:0.9

   [T, H]=ode45(@waterheight, [0 2000], h0 , [], Q , S , Sh , g );

   plot (T,H)
   grid on;
   hold on;
   xlabel('time [s]');
   ylabel('water height [m]');
   xlim([0 200]);
   ylim([0 30])
   title('Water height in a tank');
   legend({'Sh = 0.1','Sh = 0.3','Sh = 0.5','Sh = 0.7','Sh = 0.9'});
end
```

Screenshot:



3. Open the file Lab6_2.m, waterheight2.m. Change the code in such a way that both tanks have conical shape. As the volume of such cone is given by $V(h) = \frac{1}{3}Sh$ the set of differential equation changes by appearance of factor $\frac{1}{3}$ and variable cone base S. To introduce variable cone base you may replace constants `S1,S2` with functions `S1(h1),S2(h2)`. For simplicity you can assume that dimensions of both tanks are the same and `S1(h2)=S2(h2)=S(h)`. Paste the code of function waterheight2.m and new functions (if you created new functions).



$$\frac{dh_1}{dt} = \frac{Q}{\frac{1}{3}S_1(h)} - 0.6\frac{S_{h1}}{\frac{1}{3}S_1(h)}\sqrt{2gh_1}$$

$$\frac{dh_2}{dt} = 0.6\frac{S_{h1}}{\frac{1}{3}S_2(h)}\sqrt{2gh_1} - 0.6\frac{S_{h2}}{\frac{1}{3}S_2(h)}\sqrt{2gh_2}$$

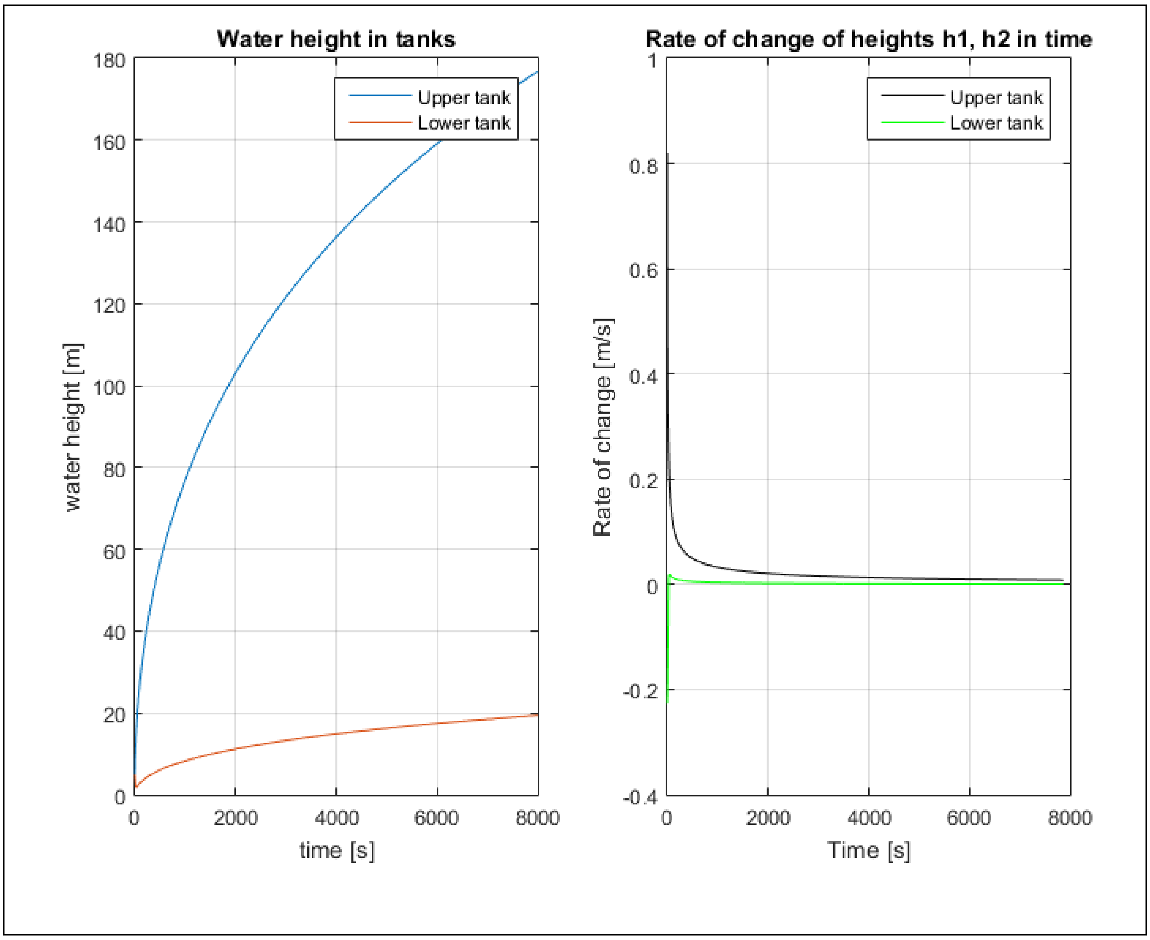
Code:

```
function dh=waterheight2(t,h)
Q=5;
S1 = 3;
Sh1=0.1;
Sh2=0.3;
g=9.81;

a=pi/2;
S1 = pi*h(1)*tan(a/2);
S2 = pi*h(2)*tan(a/2);
dh=zeros(2,1);
dh(1)=3*Q/S1-0.6*3*Sh1/S1*sqrt(2*g*h(1))
dh(2)=0.6*3*Sh1/S2*sqrt(2*g*h(1))-0.6*3*Sh2/S2*sqrt(2*g*h(2))
```


4. Using "subplot" add second plot that contains rate of change of heights `h1,h2` in time. Add proper titles to plots. Derivative can be calculated in many ways, one of them is to apply diff function (check it in help). Paste the code and screenshot with example.

Screenshot:

```
h01 = 5;
h02 = 5;

[T, H]=ode45(@waterheight2, [0 8000], [h01 h02]);


figure(1);
subplot(1,2,1);
plot (T, H)
grid on;
xlabel('time [s]');
ylabel('water height [m]');
title('Water height in tanks');
legend('Upper tank','Lower tank');

subplot(1,2,2);

Y1 = diff(H(:,1))./diff(T);
Y2 = diff(H(:,2))./diff(T);
T(end,:)=[];

plot(T, Y1,'k');
hold on;
plot(T, Y2,'g');
grid on;
xlabel('Time [s]');
ylabel('Rate of change [m/s]');
title('Rate of change of heights h1, h2 in time');
legend('Upper tank', 'Lower tank');
```



Water height in tanks
water height [m]
time [s]
Upper tank
Lower tank
0
20
40
60
80
100
120
140
160
180
0
2000
4000
6000
8000
Rate of change of heights h1, h2 in time
Rate of change [m/s]
Time [s]
Upper tank
Lower tank
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
0
2000
4000
6000
8000