1 MATLAB Code

```
clear all; close all; clc
%% Constants
Hi = 1;% initial maximum height
L  = 5;% initial max length of tip

% Intervals
M=20;% amount of space nodes
tf = 1/2;% final time to run code;
N = 10*M^2;% amount of time nodes//increase by some mult.
    k
dz = L/M;
dt = tf/(N-1);
zvec = 0:dz:L;% z vector
ndt = tf/dt;% amount of time iterations

%% Initial conditions
    h = -(Hi/L^2)*zvec.^2+Hi;% initial height profile,
        which is quadratic by guess
    plot(zvec,h,'g')% original plot over h and z
    hold on

    % Initial Volume
    iv = 0;
    for i=1:length(h)-1
        iv = iv+((h(i)+h(i+1))/2)^2*dz;
    end% for i

    %% y and Z transform
    y = h.^2;% transform h-->y
    ZVEC = zvec./L;% transform z-->Z
    dz = ZVEC(2)-ZVEC(1);% redefine dz from Z transform
    Lold = L;% initial L^2 value
    plot(ZVEC,y,'m')% plot transform y over Z

    ynew = y;% new y storage vector for finite difference

%% Time loop and spacial loop for finite differencing
    for jj = 2:ndt; % Solve h profile during next dt (ndt
        should be placed here)
        y3 = y.^(3/2);% calculates y^1.5
        ysq = y.^(1/2);% calculates square root of y
        Lnew = (Lold^2+4/3*ysq(end-1)/(dz)*dt)^(1/2);%
            Calculates new L^2
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40          DL2 = 4/3*ysq(end-1)/dz;% calculates derivative
                of L^2 before FD
41
42      %% Finite difference in space
43          ynew(1) = Lold/Lnew*y(1)+((y(2)+y(1))/(2*Lnew^2)*
                DL2-4/3*y3(1)/(Lnew^2*dz^2))*dt;% reflective
                boundary condition for evaluating y(1)
44          y(1) = ynew(1);% overwrite y(1) so the following
                FD will work
45          for ii = 2:length(ZVEC)-1;  % move along z and
                solve
46              ynew(ii) = Lold/Lnew*y(ii)+...
47                  (...
48                  ((ii*dz+dz/2)*(y(ii+1)+y(ii))-(ii*dz-dz
                        /2)*(y(ii-1)+y(ii)))/(4*dz*Lnew^2)*DL2
                        ...
49                  +2/(3*Lnew^2)*(y3(ii-1)-2*y3(ii)+y3(ii+1)
                        )/(dz^2)...
50                  )*dt;% forward time, centered space
51          end% for ii
52          y = ynew;% overright previous y with new profile
53          LL(jj) = Lnew;% LL is a vector for L through time
54          Lold = Lnew;% overwright previous L value as new
                L for next time loop
55      end % for jj
56
57      h = ynew.^(1/2);% transform y-->h
58      zvec = ZVEC.*Lnew;% transform Z-->z
59      plot(zvec,h,'linewidth',2)
60
61      % Final Volume
62      dz = zvec(2)-zvec(1);% new dz from y-->h transform
63      fv = 0;
64      for i=1:length(h)-1
65          fv = fv+((h(i)+h(i+1))/2)^2*dz;
66      end% for i
67
68      stability = tf*M^2/((N-1)*L^2)
69
70      volchange = (iv-fv)/iv*100
71  %% Plots
72  %% all plots
73  figure(1)
74  plot(ZVEC,ynew,'k','linewidth',2)
75  xlabel('$z$','Interpreter','latex','fontsize', 15);
76  ylabel('$h$','Interpreter','latex','fontsize', 15);
```

```
77 hh = legend('h(0)','y(0)','h','y');
78 set(hh,'Interpreter','latex','fontsize', 10);
79 set(gca,'Units','normalized','FontUnits','points','
       FontWeight','normal',...
80        'FontSize',9,'FontName','Times')
```