**Functions for free surface curve**

%The function serves to model the ordinary differential equation, by

%substituting required variables, in a form which enables the ode15i function

%to produce a numerical solution of the equation.

function dSydSx = fsurface(x,y,yp);

p = 2500; % density (kg/m^3)

g = 9,81; % gravity acting on system (m/s^2)

u = 0.5; % friction factor(assuming no slip)

n = 6e-3; % shear viscosity (Pa.s)

w = 3.85; % Angular velocity (1/s)

h0= 0.004;% height (m)

theta =40;% angle of repose (degrees)

R= 0.238; % radius of rotating drum (m)

Po= h0\*p\*g\*cos(theta);

kn = (2\*Po^3)/(3\*n\*p^2\*g^2\*w);

dSydSx=(yp)^3 - u\*(yp)^2 +yp -u - (1/kn)\*(R^2-(x^2+y^2));

**Function for increased angular velocity**

%The function serves to model the ordinary differential equation, by

%substituting required variables, in a form which enables the ode15i function

%to produce a numerical solution of the equation, this function operates at

%a higher angular velocity

function dSydSx = fw(x,y,yp);

p = 2500; % density (kg/m^3)

g = 9,81; % gravity acting on system (m/s^2)

u = 0.5; % friction factor(assuming no slip)

n = 6e-3; % shear viscosity (Pa.s)

w = 4.71; % Increased Angular velocity (1/s)

h0= 0.004;% height (m)

theta =40;% angle of repose (degrees)

R= 0.238; % radius of rotating drum (m)

%theta =0.689132 ;

Po= h0\*p\*g\*cos(theta);

kn = (2\*Po^3)/(3\*n\*p^2\*g^2\*w);

dSydSx=(yp)^3 - u\*(yp)^2 +yp -u - (1/kn)\*(R^2-(x^2+y^2));

**Function for decreased angular velocity**

%The function serves to model the ordinary differential equation, by

%substituting required variables, in a form which enables the ode15i function

%to produce a numerical solution of the equation, with a lower angular

%velocity

function dSydSx = fwlower(x,y,yp);

p = 2500; % density (kg/m^3)

g = 9,81; % gravity acting on system (m/s^2)

u = 0.5; % friction factor(assuming no slip)

n = 6e-3; % shear viscosity (Pa.s)

w = 2.99; % Decreased Angular velcoity (1/s)

h0= 0.004;% height (m)

theta =40;% angle of repose (degrees)

R= 0.238; % radius of rotating drum (m)

Po= h0\*p\*g\*cos(theta);

kn = (2\*Po^3)/(3\*n\*p^2\*g^2\*w);

dSydSx=(yp)^3 - u\*(yp)^2 +yp -u - (1/kn)\*(R^2-(x^2+y^2));

**Function for Increased Friction factor**

%The function serves to model the ordinary differential equation, by

%substituting required variables, in a form which enables the ode15i function

%to produce a numerical solution of the equation, with an increased

%friction factor

function dSydSx = fuup(x,y,yp);

p = 2500; % density (kg/m^3)

g = 9,81; % gravity acting on system (m/s^2)

u = 0.7; % Increased friction factor(assuming no slip)

n = 6e-3; % shear viscosity (Pa.s)

w = 3.85; % Angular velocity (1/s)

h0= 0.004;% height (m)

theta =40;% angle of repose (degrees)

R= 0.238; % radius of rotating drum (m)

Po= h0\*p\*g\*cos(theta);

kn = (2\*Po^3)/(3\*n\*p^2\*g^2\*w);

dSydSx=(yp)^3 - u\*(yp)^2 +yp -u - (1/kn)\*(R^2-(x^2+y^2));

**Function for Decreased Friction factor**

%The function serves to model the ordinary differential equation, by

%substituting required variables, in a form which enables the ode15i function

%to produce a numerical solution of the equation, with decreased friction

%factor

function dSydSx = fulow(x,y,yp);

p = 2500; % density (kg/m^3)

g = 9,81; % gravity acting on system (m/s^2)

u = 0.3; % Decreased friction factor(assuming no slip)

n = 6e-3; % shear viscosity (Pa.s)

w = 3.85; % Angular velocity (1/s)

h0= 0.004;% height (m)

theta =40;% angle of repose (degrees)

R= 0.238; % radius of rotating drum (m)

Po= h0\*p\*g\*cos(theta);

kn = (2\*Po^3)/(3\*n\*p^2\*g^2\*w);

dSydSx=(yp)^3 - u\*(yp)^2 +yp -u - (1/kn)\*(R^2-(x^2+y^2));

**Function for Increased shear viscosity**

%The function serves to model the ordinary differential equation, by

%substituting required variables, in a form which enables the ode15i function

%to produce a numerical solution of the equation, increased viscosity

function dSydSx = fvisup(x,y,yp);

p = 2500; % density (kg/m^3)

g = 9,81; % gravity acting on system (m/s^2)

u = 0.5; % friction factor(assuming no slip)

n = 5e-3; % Increased shear viscosity (Pa.s)

w = 3.85; % Angular velocity (1/s)

h0= 0.004;% height (m)

theta =40;% angle of repose (degrees)

R= 0.238; % radius of rotating drum (m

%theta =0.689132 ;

R= 0.238;

Po= h0\*p\*g\*cos(theta);

kn = (2\*Po^3)/(3\*n\*p^2\*g^2\*w);

dSydSx=(yp)^3 - u\*(yp)^2 +yp -u - (1/kn)\*(R^2-(x^2+y^2));

**Function for decreased shear viscosity**

%The function serves to model the ordinary differential equation, by

%substituting required variables, in a form which enables the ode15i function

%to produce a numerical solution of the equation. This function uses a

%lower viscosity for the ODE

function dSydSx = fvislower(x,y,yp);

p = 2500; % density (kg/m^3)

g = 9,81; % gravity acting on system (m/s^2)

u = 0.5; % friction factor(assuming no slip)

n = 7e-3; %decreased viscosity (Pa.s)

w = 3.85; % Angular velocity (1/s)

h0= 0.004;% height (m)

theta =40;% angle of repose (degrees) %0.689132 ;

R= 0.238; % radius of rotating drum (m)

Po= h0\*p\*g\*cos(theta);

kn = (2\*Po^3)/(3\*n\*p^2\*g^2\*w);

dSydSx=(yp)^3 - u\*(yp)^2 +yp -u - (1/kn)\*(R^2-(x^2+y^2));