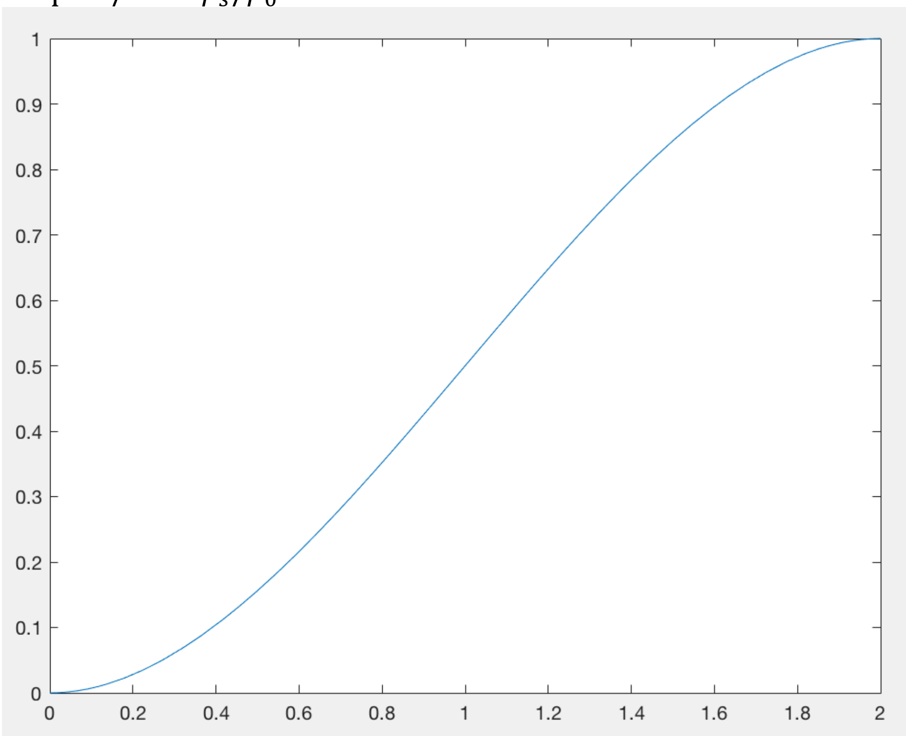
Assignment 3

1.

Height is 45.3mm given the input $r = 40mm, \rho_s = 0.6g/mm^3, \rho_0 = 1g/mm^3$.

Graph $h/r \;\; vs. \rho_s/\rho_0$



When $\rho_s/\rho_0 < 1$, as it increases, the sphere depth below the fluid surface increases, as a result h/r increases.

When $\rho_s/\rho_0 > 1$, the sphere density is larger than the fluid density. Sphere will submerge.

Matlab Code:

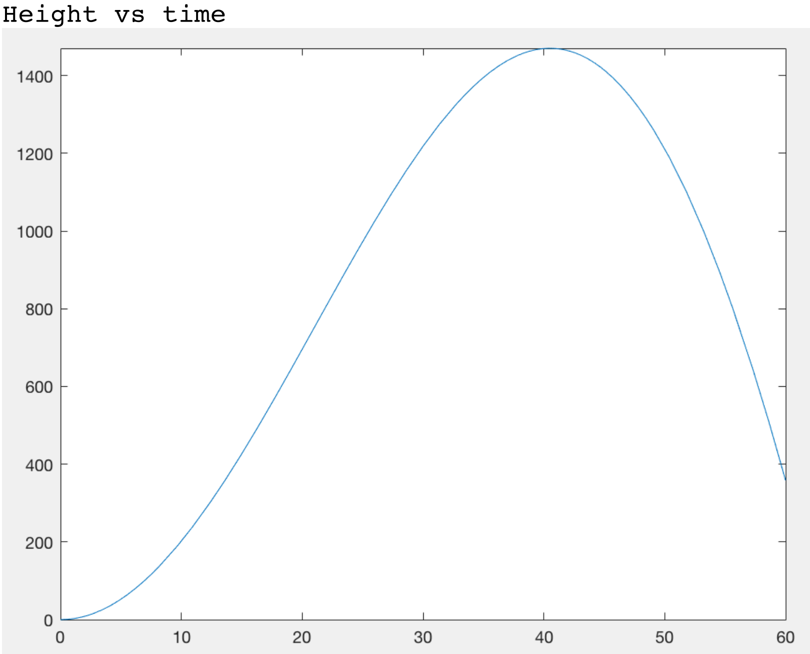
```
% Prompt user for input
radius = input('Radius: ');
sphere_density = input('Solid sphere density: ');
fluid_density = input('Fluid Density: ');

% Calculate depth
h=0:0.01:1.5;
y1 = pi*((3*radius*h.^2-h.^3)*fluid_density/3-
4*radius^3*sphere_density/3);

plot(h, y1)

for i=1:length(h)-1
    if y1(i)*y1(i+1) < 0 && h(i) < 2*radius
        fprintf('Height is %d \n',h(i));
    end
end
```

```
% Plot the graph of h/r vs sphere_density/fluid_density
so_ratio = @(hr_ratio) (3*hr_ratio.^2-hr_ratio.^3)/4
fplot(so_ratio, [0 2])
```

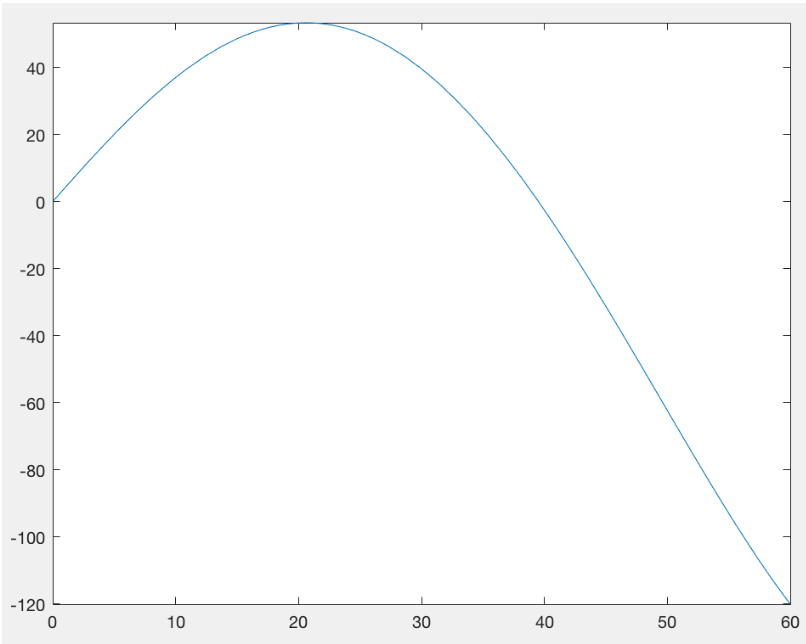
2.

```
% a) calculate the rocket height and speed at a given time
t = input('Time: ');
H = R_motion(t);

function Height = R_motion(t)
    Height = 2.13*t^2-0.0013*t^4+0.000034*t^4.751;

% b) create a function handle to R_motion.
R_motion_handle = @(t) R_motion(t);

% c) plot the rocket height and velocity with time
figure;
fplot(R_motion_handle, [0 60]);
% take the derivative for velocity with time
Velocity = @(t) 4.13*t-4*0.0013*t^3+4.751*0.000034*t^3.751;
figure;
fplot(Velocity, [0 60]);
```

Height vs time

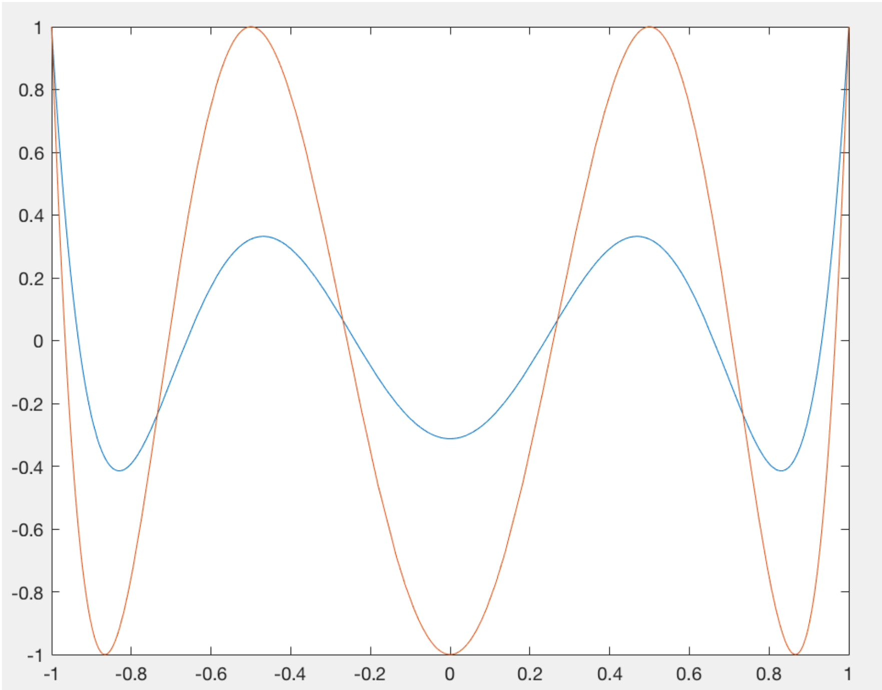


Velocity vs time



3.
The solution for Legendre is
-9.400000e-01
-6.700000e-01
-2.400000e-01
2.300000e-01
6.600000e-01
9.300000e-01
The solution for Chebyshey is
-9.700000e-01
-7.100000e-01
-2.600000e-01
2.500000e-01
7.000000e-01
9.600000e-01

The roots is symmetric to y axis.

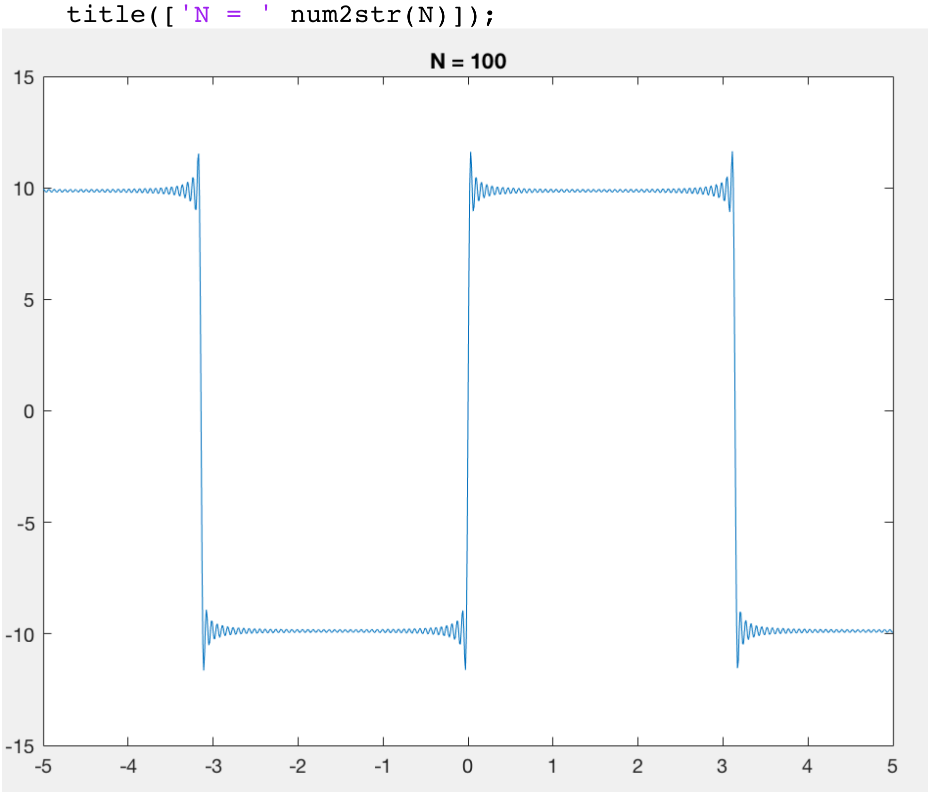


Matlab code:

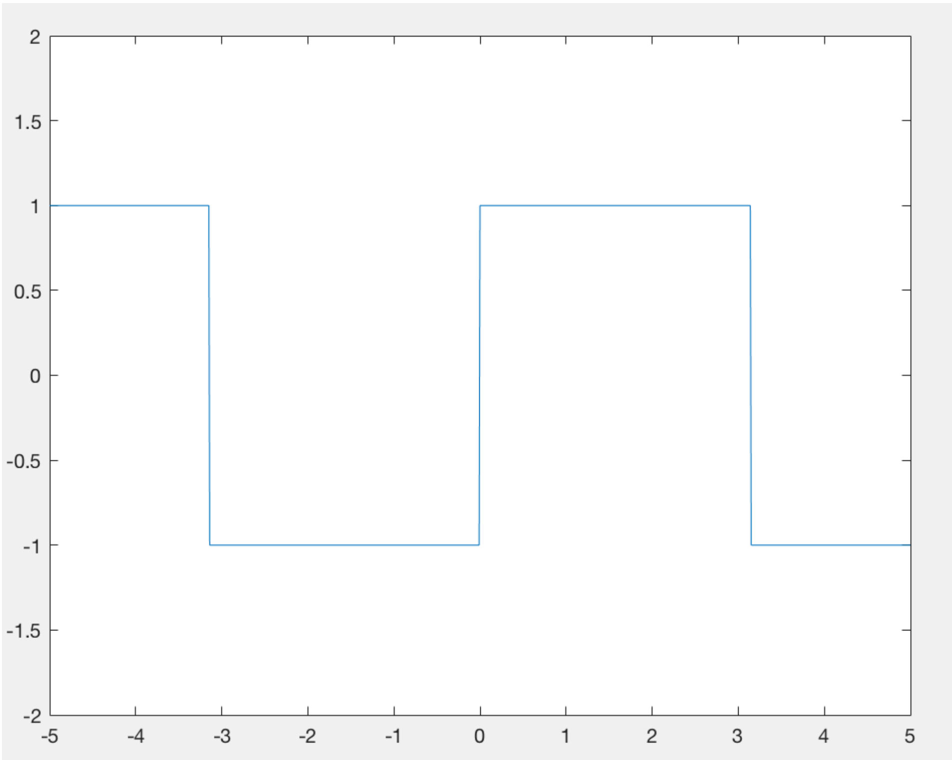
```
% Legendre polynomial
x=-1:0.01:1;
y1 = (693*x.^6-945*x.^4+315*x.^2-15)./48;
fprintf('The solution for Legendre is \n');
for i=1:length(x)-1
    if y1(i)*y1(i+1) < 0
        fprintf('%d \n', x(i));
    end
end

% Chebyshev polynomial
x2=-1:0.01:1;
y2 = 32*x2.^6-48*x2.^4+18*x2.^2-1;
fprintf('The solution for Chebyshey is \n');
for i=1:length(x2)-1
    if y2(i)*y2(i+1) < 0
        fprintf('%d \n', x2(i));
    end
end

% Plot graphs
plot(x, y1);
hold on;
plot(x2, y2);
hold off;
```

4.
For N getting larger, the Fourier series getting closer to the periodic function.

Fourier series function:
```
function y = Fourier_series(N)
    y=0;
    k=1;
    x=-5:0.01:5;
    for i=1:N
        bn=2*k*(1-cos(i*pi))/i*pi;
        y=y+bn*sin(i*x);
    end
    plot(x, y);
    title(['N = ' num2str(N)]);
```



Periodic function:
```
function y = periodic_function()
    k = 1;
    x = -5:0.01:5;
    y = zeros(1, length(x));
    for i=1:length(x)
        if mod(floor(x(i)/pi),2) == 0
            y(i)=k;
        else
            y(i)=-k;
        end
    end
    plot(x,y);
    ylim([-2 2]);
```



Choose a value of N and give your reason why it is a appropriate approximation.