



PhySoc Matlab Session

*-Dept. Of Physics*

# Goals

- **Introduction to coding in Matlab.**
- **Creating Simulations in Matlab.**
- **Configuration and Phase Space of Classical Harmonic Oscillator.**

# Sections of Matlab Window

The screenshot displays the MATLAB desktop environment. The top ribbon contains several tabs: FILE, VARIABLE, CODE, SIMULINK, ENVIRONMENT, and RESOURCES. The main workspace is divided into three panels:

- Current Folder:** Shows the current directory as `C:\Users\Kushagra Nigam\Documents\MATLAB`.
- Command Window:** Contains the following code:

```
>> a=1  
  
a =  
  
1  
  
>> clear  
fx >> |
```
- Workspace:** A table showing the current workspace variables. It has columns for Name, Value, and Memory. The table is currently empty.
- Command History:** A list of previously executed commands, including:

```
a=[1 2 3; 3 4 5; 6 7 8]  
clc  
clear  
clc  
help if  
a = zeros(2,3)  
clc  
clear  
clc  
a=1
```

# Let's Get Started

## Basic Operations:

- Variable Declaration
- Matrix Declaration
- Matrix of Zeros
- Help in Matlab

## Examples:

- `a = 1`
- `a = 1;`
- `a = [1 2 3]`
- `a = [1 2 3; 4 5 6; 7 8 9]`
- `a = zeros(2,3)`
- `help if`
- `clc` (clears the com. window)
- `clear` (clears the work space)

# Learning via Coding



# Main Problem

## Analyze Classical Simple Harmonic Oscillator

**Plot its total energy surface, energy curves, displacement curves and create a real time simulation of its configuration and phase space.**

**Ask user for initial conditions.**

# Sub problem #1

## Plotting a Function:

- $f(x) = \sin(x)$ ;

Well function needs a domain !!

Check out help `plot`

# Sub problem #1

## Plotting a Function:

Code Snippet :

```
>>x= 0 : 0.0001 : 6*pi ;
```

```
>>y = sin(x);
```

```
>>plot(x,y);
```

```
% try plot(x(1:1000),y(1:1000));
```

```
grid on;
```

```
xlabel('time');
```

```
ylabel('displacement');
```

```
title('SHO');
```



# Sub problem #2

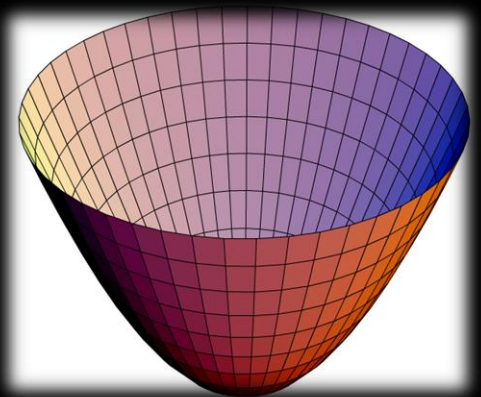
## Plotting a Surface:

**Well what's a surface and a level curve??**

**Examples:**

**$F = F(x,y) = x^2 + y^2$ ; (Paraboloid)**

- **What are degrees of freedom??**
- **What is dimensionality of this surface??**
- **What are its level curves??**

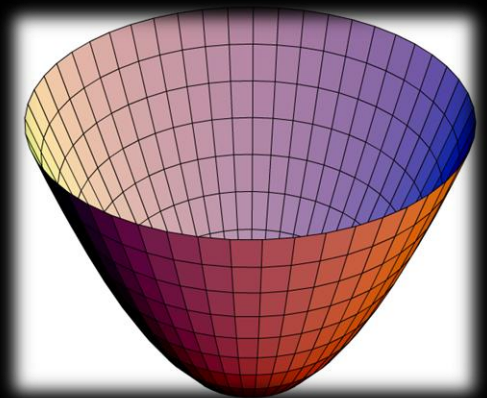


# Sub problem #2

## Plotting a Surface:

**Step 1 : Create a x-y coordinate mesh**

```
>> x=-100:2:100;  
>> y=-200:2:200;  
>> [X,Y]=meshgrid(x,y);  
>> Z=X.^2 + Y.^2;  
>> surface(X,Y,Z);  
grid on  
xlabel('x->');  
ylabel('y->');  
zlabel('z->');
```



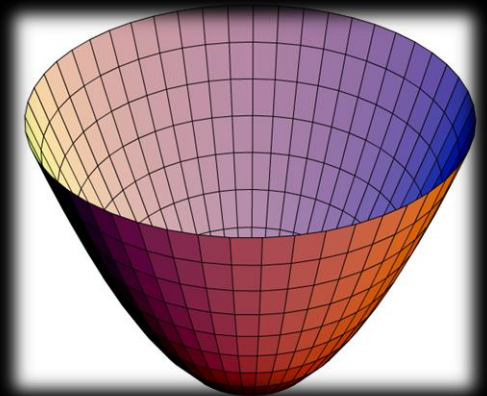
Dude!  
Please get rid of command window



# Sub problem #2

Create a Matlab Script save it as name.m and CODE!!

```
x=-100:2:100;  
y=-200:2:200;  
[X,Y]=meshgrid(x,y);  
surface(X,Y,Z);  
grid on  
xlabel('x->');  
ylabel('y->');  
zlabel('z->');
```



# Sub problem #3

## Creating Real Time Animations:

### Basic Idea:

Create frames of data points and show them at  
A particular fps.

```
clc
clear
figure('Renderer','zbuffer')
dt=0.1;
t=0: dt :2*pi;
N=size(t,2);
y=zeros(N);
```

```
for i=1:N
    y(i)=sin(t(i));
    plot(t(1:i),y(1:i),'bX');
    grid on;
    axis([0 max(t) -2 2])
    M(i)=getframe;
end
movie(M);
```

Let's get back to basics buddies !!



# Sub problem #4

Ordinary Differential Equation of 1<sup>st</sup> order:

**Initial Value Problem:**

Example:

$$dy/dx = -4x;$$

- How many initial conditions are required to solve it?
- How do we define  $dy/dx$ ?

# Sub problem #4

Ordinary Differential Equation of 1<sup>st</sup> order:

**$dy/dt = -4t$ ; Taylor Expand  $y(t + \Delta t)$**

- In limit  $\Delta t \rightarrow 0$   $y(t + dt) = y(t) + y'(t) * dt$  ;
- So accuracy depends on selection of  $dt$
- Code the problem!!



# Sub problem #4



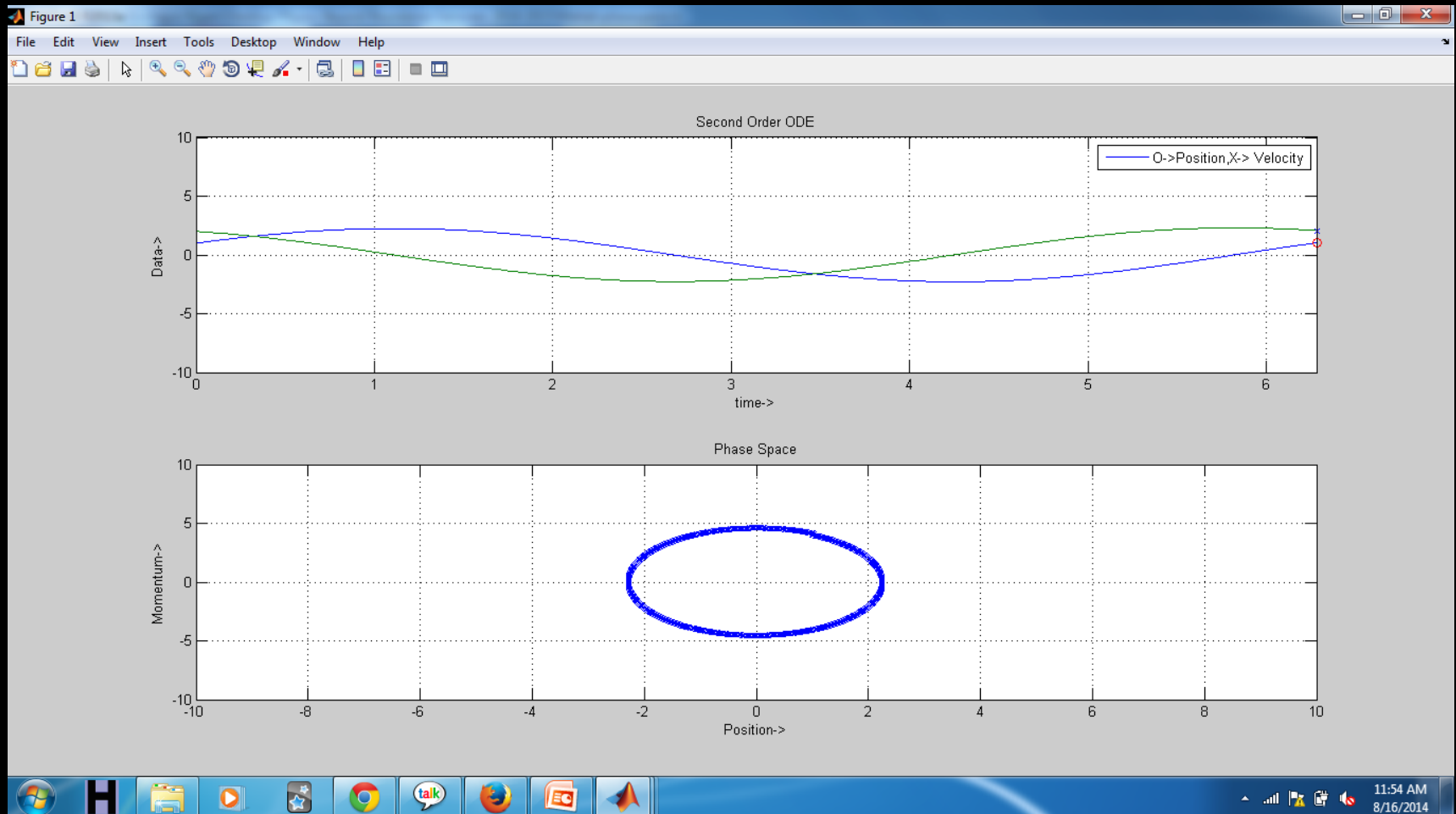
Ordinary Differential Equation of 2<sup>nd</sup> order:

$$d^2y/dt^2 = -4y;$$

- Split the Differential Equation in two 1<sup>st</sup> order ODE.
- $dy/dt = w$  and  $dw/dt = -4y$

# Sub problem #5

## Phase Curves:



Thanks!!

