MATHEMATICAL MODELING

LECTURER OF Q-CLASS: PROF. DR. BASUKI WIDODO, M.SC

2ND QUIZ | VENANSIUS RYAN TJAHJONO 06111540000043

Departemen Matematika
Fakultas Matematika, Komputasi, dan Sains Data
Institut Teknologi Sepuluh Nopember
Surabaya 2018

SKYDIVING PROBLEM – SIMULATION WITH MATLAB

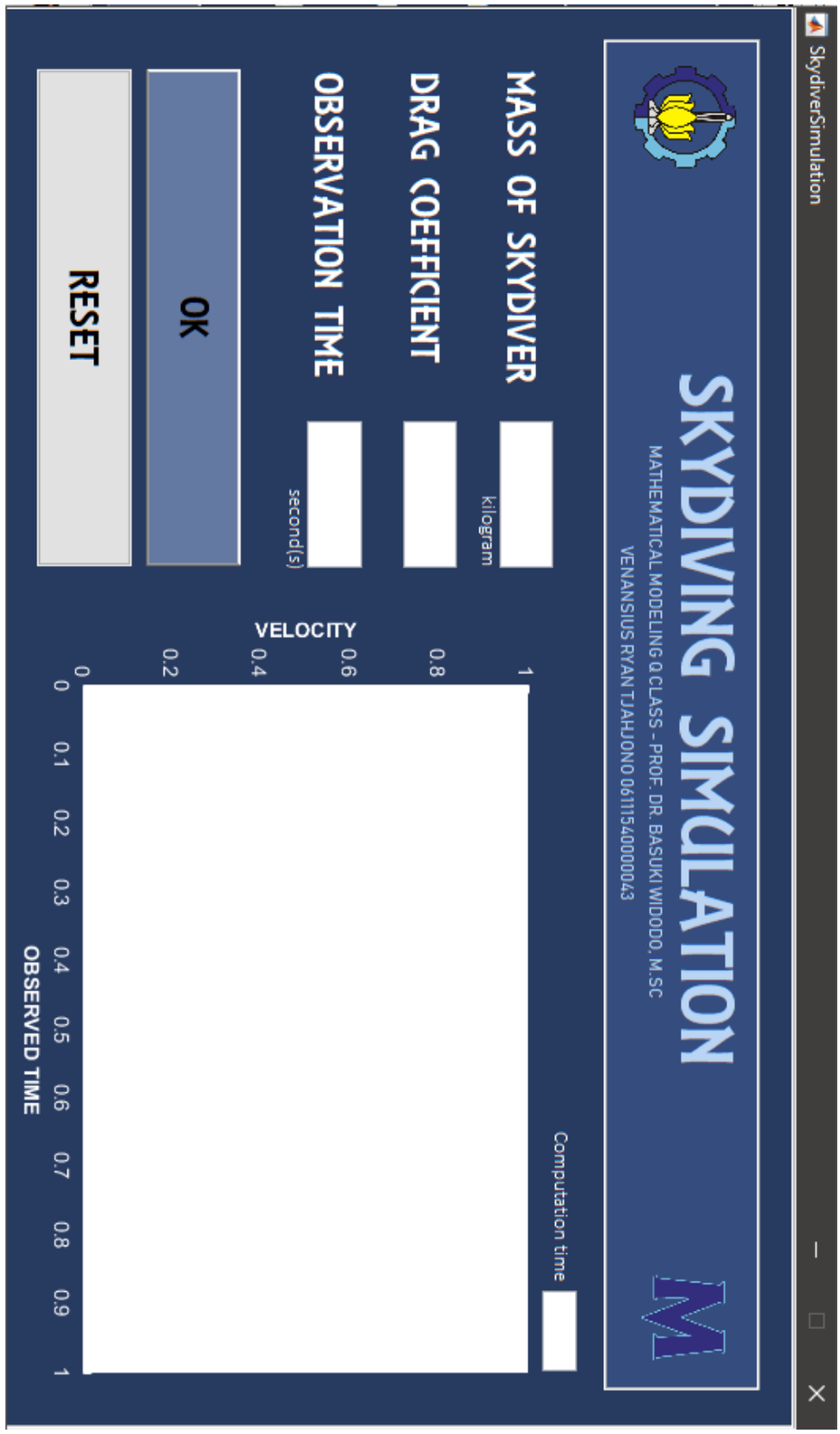
SOURCE CODE

```
function varargout = SkydiverSimulation(varargin)
% SKYDIVERSIMULATION MATLAB code for SkydiverSimulation.fig
%      SKYDIVERSIMULATION, by itself, creates a new SKYDIVERSIMULATION or raises the
existing
%      singleton*.
%
%      H = SKYDIVERSIMULATION returns the handle to a new SKYDIVERSIMULATION or the handle
to
%      the existing singleton*.
%
%      SKYDIVERSIMULATION('CALLBACK',hObject,eventData,handles,...) calls the local
%      function named CALLBACK in SKYDIVERSIMULATION.M with the given input arguments.
%
%      SKYDIVERSIMULATION('Property','Value',...) creates a new SKYDIVERSIMULATION or
raises the
%      existing singleton*.  Starting from the left, property value pairs are
%      applied to the GUI before SkydiverSimulation_OpeningFcn gets called.  An
%      unrecognized property name or invalid value makes property application
%      stop.  All inputs are passed to SkydiverSimulation_OpeningFcn via varargin.
%
%      *See GUI Options on GUIDE's Tools menu.  Choose "GUI allows only one
%      instance to run (singleton)".
%
% See also: GUIDE, GUIDATA, GUIHANDLES

% Edit the above text to modify the response to help SkydiverSimulation

% Last Modified by GUIDE v2.5 28-Nov-2018 22:50:13

% Begin initialization code - DO NOT EDIT
gui_Singleton = 1;
gui_State = struct('gui_Name',       mfilename, ...
                   'gui_Singleton',  gui_Singleton, ...
                   'gui_OpeningFcn', @SkydiverSimulation_OpeningFcn, ...
                   'gui_OutputFcn',  @SkydiverSimulation_OutputFcn, ...
                   'gui_LayoutFcn',  [] , ...
                   'gui_Callback',   []);
if nargin && ischar(varargin{1})
    gui_State.gui_Callback = str2func(varargin{1});
end

if nargout
    [varargout{1:nargout}] = gui_mainfcn(gui_State, varargin{:});
else
    gui_mainfcn(gui_State, varargin{:});
end
% End initialization code - DO NOT EDIT


% --- Executes just before SkydiverSimulation is made visible.
function SkydiverSimulation_OpeningFcn(hObject, eventdata, handles, varargin)
% This function has no output args, see OutputFcn.
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% varargin   command line arguments to SkydiverSimulation (see VARARGIN)

% Choose default command line output for SkydiverSimulation
handles.output = hObject;
```

```
axes(handles.axes1)
imshow('picits1.png')

axes(handles.axes2)
imshow('picmath1.png')

axes(handles.axes3)
xlabel('OBSERVED TIME','FontSize',10,'FontWeight','bold','Color','w');
ylabel('VELOCITY','FontSize',10,'FontWeight','bold','Color','w');
set(handles.axes3, 'XColor', 'w');
set(handles.axes3, 'YColor', 'w');

% Update handles structure
guidata(hObject, handles);

% UIWAIT makes SkydiverSimulation wait for user response (see UIRESUME)
% uiwait(handles.figure1);


% --- Outputs from this function are returned to the command line.
function varargout = SkydiverSimulation_OutputFcn(hObject, eventdata, handles)
% varargout  cell array for returning output args (see VARARGOUT);
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Get default command line output from handles structure
varargout{1} = handles.output;



function edit1_Callback(hObject, eventdata, handles)
% hObject    handle to edit1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit1 as text
%        str2double(get(hObject,'String')) returns contents of edit1 as a double


% --- Executes during object creation, after setting all properties.
function edit1_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end



function edit4_Callback(hObject, eventdata, handles)
% hObject    handle to edit4 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
```

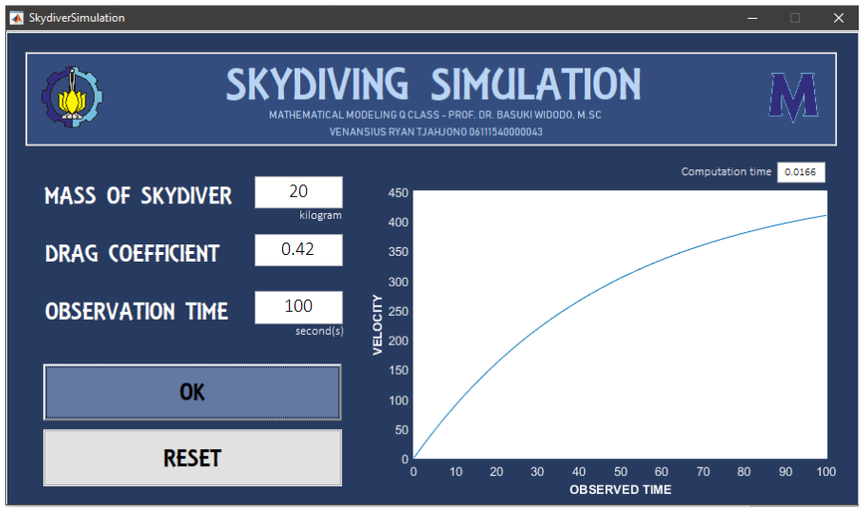
```
% Hints: get(hObject,'String') returns contents of edit4 as text
%        str2double(get(hObject,'String')) returns contents of edit4 as a double


% --- Executes during object creation, after setting all properties.
function edit4_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit4 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end



function edit5_Callback(hObject, eventdata, handles)
% hObject    handle to edit5 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit5 as text
%        str2double(get(hObject,'String')) returns contents of edit5 as a double


% --- Executes during object creation, after setting all properties.
function edit5_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit5 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end



% --- Executes on button press in pushbutton1.
function pushbutton1_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
tic;
m = str2num(get(handles.edit1,'String'));
c = str2num(get(handles.edit4,'String'));
t = str2num(get(handles.edit5,'String'));

T = 0:t;
v = [];
g = 9.8;

for i = T
    v(i+1) = (m*g/c)*(1-exp(-c*i/m));
end

plot(T,v);
xlabel('OBSERVED TIME','FontSize',10,'FontWeight','bold','Color','w');
ylabel('VELOCITY','FontSize',10,'FontWeight','bold','Color','w');
```

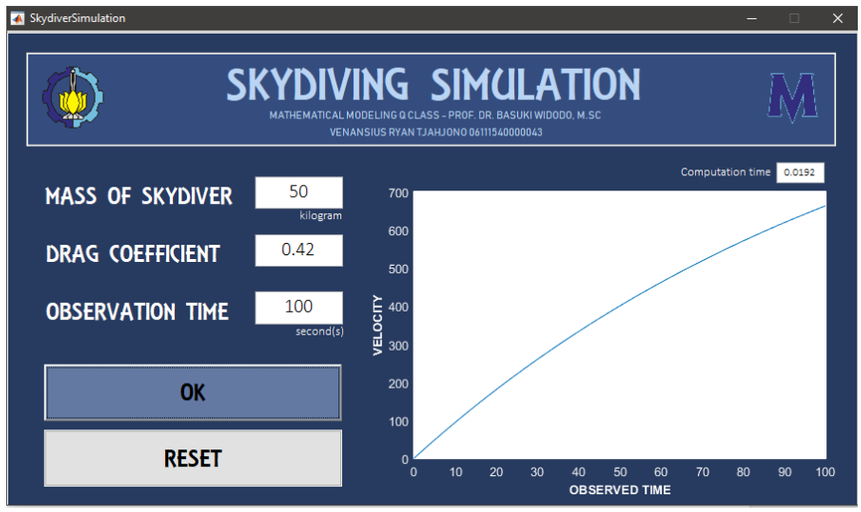
```
set(handles.axes3, 'XColor', 'w');
set(handles.axes3, 'YColor', 'w');
set(handles.edit8, 'String', round(toc*10000)/10000)

% --- Executes on button press in pushbutton2.
function pushbutton2_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
set(handles.edit1, 'String', '')
set(handles.edit4, 'String', '')
set(handles.edit5, 'String', '')
set(handles.edit8, 'String', '')
cla(handles.axes3)

function edit8_Callback(hObject, eventdata, handles)
% hObject    handle to edit8 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit8 as text
%        str2double(get(hObject,'String')) returns contents of edit8 as a double


% --- Executes during object creation, after setting all properties.
function edit8_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit8 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end
```

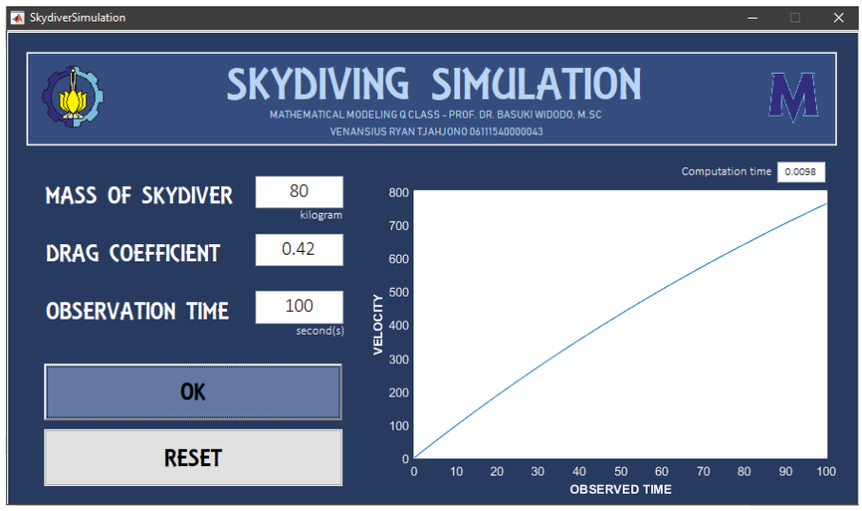


GRAPHICAL USER INTERFACE

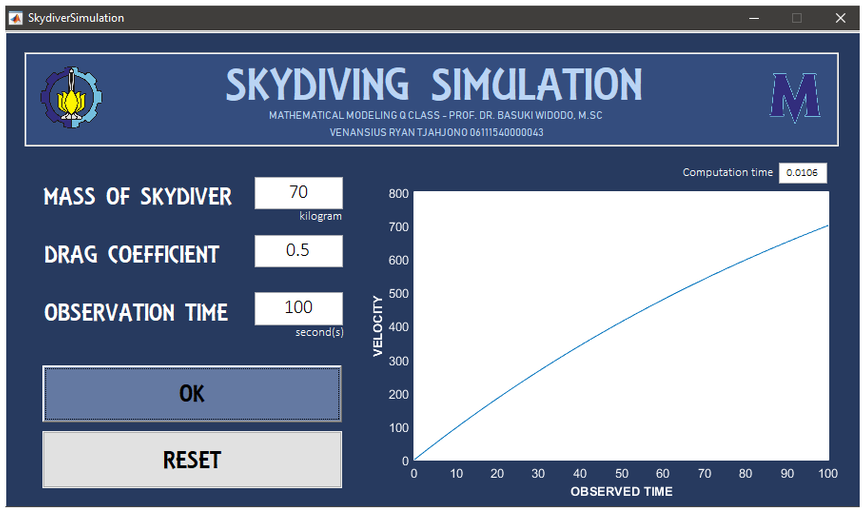
SIMULATION RESULT WITH VARIOUS MASS OF SKYDIVER AND DRAG COEFFICIENT = 0.42

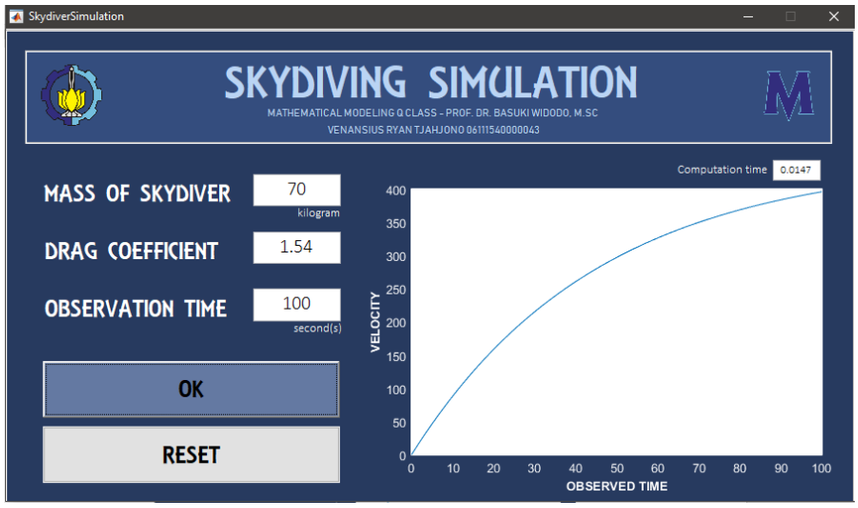


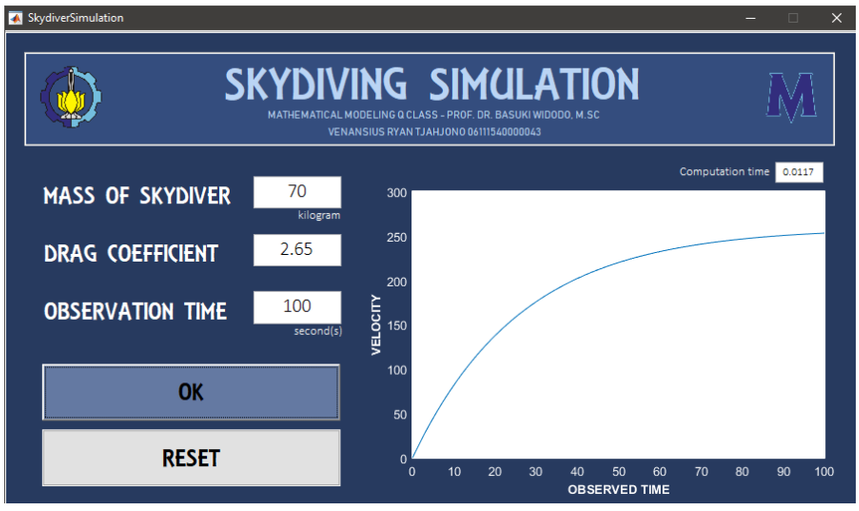




SIMULATION RESULT WITH VARIOUS DRAG COEFFICIENT AND MASS OF SKYDIVER = 70 KG







CONCLUSION

As a skydiver falls, he accelerates downwards, gaining speed with each second. The increase in speed is accompanied by an increase in air resistance (as observed in the animation below). This force of air resistance counters the force of gravity. As the skydiver falls faster and faster, the amount of air resistance increases more and more until it approaches the magnitude of the force of gravity. Once the force of air resistance is as large as the force of gravity, a balance of forces is attained and the skydiver no longer accelerates. The skydiver is said to have reached a terminal velocity.

MUSICAL INSTRUMENT STRING PROBLEM – SIMULATION WITH MATLAB

SOUCE CODE

```
function varargout = StringSimulationGui(varargin)
% STRINGSIMULATIONGUI MATLAB code for StringSimulationGui.fig
%      STRINGSIMULATIONGUI, by itself, creates a new STRINGSIMULATIONGUI or raises the
existing
%      singleton*.
%
%      H = STRINGSIMULATIONGUI returns the handle to a new STRINGSIMULATIONGUI or the
handle to
%      the existing singleton*.
%
%      STRINGSIMULATIONGUI('CALLBACK',hObject,eventData,handles,...) calls the local
%      function named CALLBACK in STRINGSIMULATIONGUI.M with the given input arguments.
%
%      STRINGSIMULATIONGUI('Property','Value',...) creates a new STRINGSIMULATIONGUI or
raises the
%      existing singleton*.  Starting from the left, property value pairs are
%      applied to the GUI before StringSimulationGui_OpeningFcn gets called.  An
%      unrecognized property name or invalid value makes property application
%      stop.  All inputs are passed to StringSimulationGui_OpeningFcn via varargin.
%
%      *See GUI Options on GUIDE's Tools menu.  Choose "GUI allows only one
%      instance to run (singleton)".
%
% See also: GUIDE, GUIDATA, GUIHANDLES

% Edit the above text to modify the response to help StringSimulationGui

% Last Modified by GUIDE v2.5 28-Nov-2018 20:19:52

% Begin initialization code - DO NOT EDIT
gui_Singleton = 1;
gui_State = struct('gui_Name',       mfilename, ...
                   'gui_Singleton',  gui_Singleton, ...
                   'gui_OpeningFcn', @StringSimulationGui_OpeningFcn, ...
                   'gui_OutputFcn',  @StringSimulationGui_OutputFcn, ...
                   'gui_LayoutFcn',  [] , ...
                   'gui_Callback',   []);
if nargin && ischar(varargin{1})
    gui_State.gui_Callback = str2func(varargin{1});
end

if nargout
    [varargout{1:nargout}] = gui_mainfcn(gui_State, varargin{:});
else
    gui_mainfcn(gui_State, varargin{:});
end
% End initialization code - DO NOT EDIT


% --- Executes just before StringSimulationGui is made visible.
function StringSimulationGui_OpeningFcn(hObject, eventdata, handles, varargin)
% This function has no output args, see OutputFcn.
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% varargin   command line arguments to StringSimulationGui (see VARARGIN)

% Choose default command line output for StringSimulationGui
handles.output = hObject;
axes(handles.axes2);
```

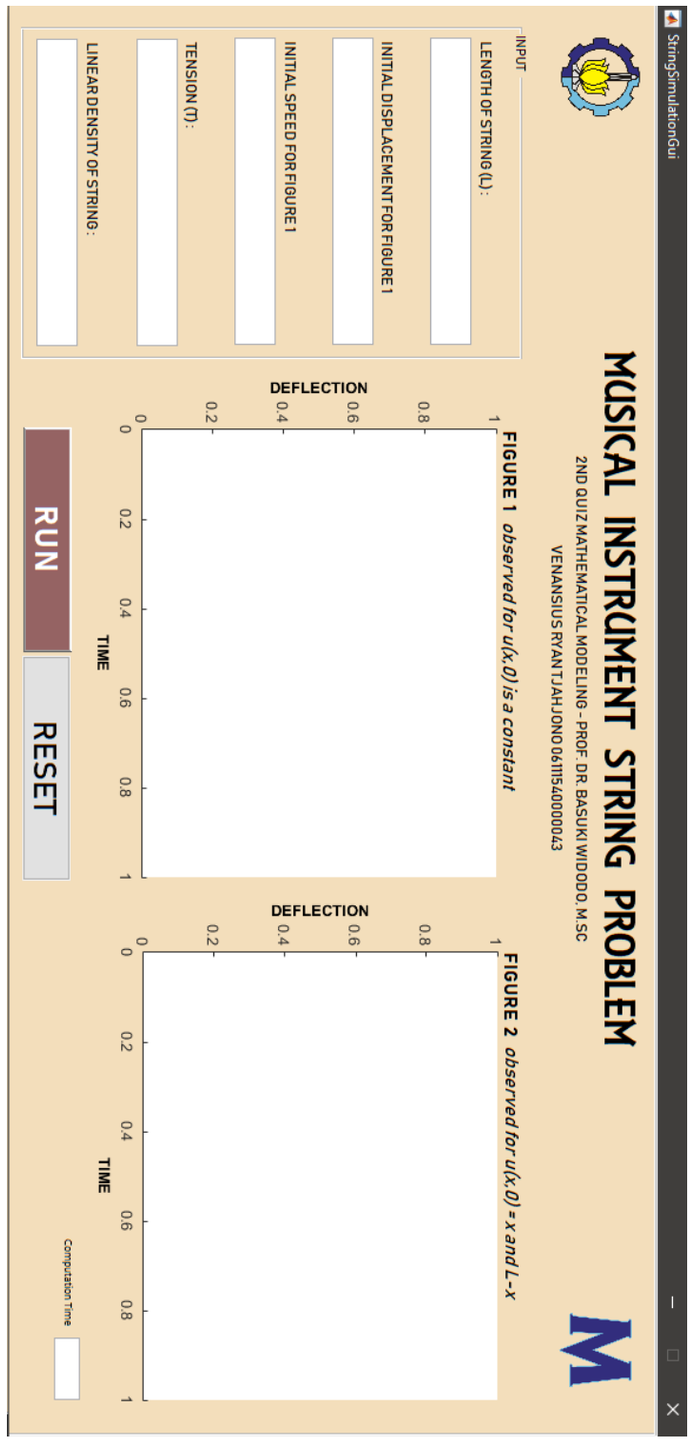
```
imshow('picits1.png');
axes(handles.axes3);
imshow('picmath1.png');

axes(handles.axes4);
xlabel('TIME','FontSize',10,'FontWeight','bold','Color','k');
ylabel('DEFLECTION','FontSize',10,'FontWeight','bold','Color','k');

axes(handles.axes1);
xlabel('TIME','FontSize',10,'FontWeight','bold','Color','k');
ylabel('DEFLECTION','FontSize',10,'FontWeight','bold','Color','k');

% Update handles structure
guidata(hObject, handles);

% UIWAIT makes StringSimulationGui wait for user response (see UIRESUME)
% uiwait(handles.figure1);


% --- Outputs from this function are returned to the command line.
function varargout = StringSimulationGui_OutputFcn(hObject, eventdata, handles)
% varargout  cell array for returning output args (see VARARGOUT);
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Get default command line output from handles structure
varargout{1} = handles.output;


% --- Executes on button press in pushbutton1.
function pushbutton1_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton1 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
cla(handles.axes1); cla(handles.axes4); axes(handles.axes1);
tic;
L = str2num(get(handles.edit2,'String'));
u0 = str2num(get(handles.edit3,'String'));
ut0 = str2num(get(handles.edit4,'String'));
T = str2num(get(handles.edit5,'String'));
miu = str2num(get(handles.edit6,'String'));

n = [1 2 3 4 5];
omega = zeros([1 5]);

%% PRINT FIGURE 1%%
for i = 1:1:5
    omega(i) = n(i)*pi*sqrt(T/miu)/L;
end

t = 0:0.01:3;
x = 1;
u = zeros([5 301]);
a = zeros([1 5]);
b = zeros([1 5]);

for i = 1:1:5
    b(i) = u0/sin(n(i)*pi*x/L);
end

for i = 1:1:5
    a(i) = ut0/(omega(i)*sin(n(i)*pi*x/L));
```

```
end

for j = 1:1:5
    for i = 1:1:301
        u(j,i) = sin(n(j)*pi*x/L)*(a(j)*sin(omega(j)*t(i))+b(j)*cos(omega(j)*t(i)));
    end
end

for i = 1:1:5
    plot(t,u(i,:), 'linewidth', 1.15); hold on;
end

grid on;
legend('n = 1','n = 2','n = 3','n = 4','n = 5');
xlabel('TIME','FontSize',10,'FontWeight','bold','Color','k');
ylabel('DEFLECTION','FontSize',10,'FontWeight','bold','Color','k');
handles.axes1.GridColor = 'k';

%%PRINT FIGURE 2%%
axes(handles.axes4);
for i = 1:1:5
    b(i) = ((4*L)/(n(i)*pi)^2)*(sin(n(i)*pi/2));
end

for j = 1:1:5
    for ix = 1:3
        U(j,ix) = b(j)*sin(n(j)*pi*x/L)*cos(n(j)*pi*sqrt(T/miu)*ix/L);
    end
end

for count = 1:1:5
    plot(1:3,U(count,:), 'linewidth', 1.5); hold on;
end

legend('n = 1','n = 2','n = 3','n = 4','n = 5');
xlabel('TIME','FontSize',10,'FontWeight','bold','Color','k');
ylabel('DEFLECTION','FontSize',10,'FontWeight','bold','Color','k');
handles.axes4.GridColor = 'k';
grid on;

set(handles.edit7,'String',toc);

% --- Executes on button press in pushbutton3.
function pushbutton3_Callback(hObject, eventdata, handles)
% hObject    handle to pushbutton3 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
set(handles.edit2,'String','');
set(handles.edit3,'String','');
set(handles.edit4,'String','');
set(handles.edit5,'String','');
set(handles.edit6,'String','');
set(handles.edit7,'String','');

axes(handles.axes1);
title('');
legend('hide');
cla(handles.axes1);
grid off

axes(handles.axes4);
title('');
legend('hide');
cla(handles.axes4);
```

```
grid off

function edit2_Callback(hObject, eventdata, handles)
% hObject    handle to edit2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit2 as text
%        str2double(get(hObject,'String')) returns contents of edit2 as a double


% --- Executes during object creation, after setting all properties.
function edit2_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit2 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end



function edit3_Callback(hObject, eventdata, handles)
% hObject    handle to edit3 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit3 as text
%        str2double(get(hObject,'String')) returns contents of edit3 as a double


% --- Executes during object creation, after setting all properties.
function edit3_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit3 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end



function edit4_Callback(hObject, eventdata, handles)
% hObject    handle to edit4 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit4 as text
%        str2double(get(hObject,'String')) returns contents of edit4 as a double


% --- Executes during object creation, after setting all properties.
function edit4_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit4 (see GCBO)
```

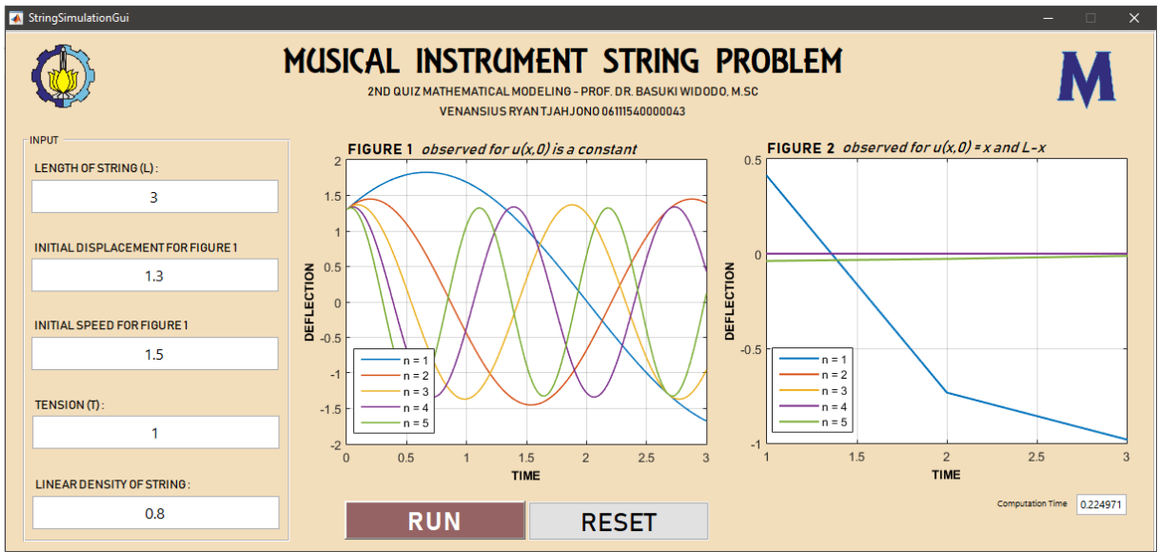
```
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end



function edit5_Callback(hObject, eventdata, handles)
% hObject    handle to edit5 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit5 as text
%        str2double(get(hObject,'String')) returns contents of edit5 as a double


% --- Executes during object creation, after setting all properties.
function edit5_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit5 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end



function edit6_Callback(hObject, eventdata, handles)
% hObject    handle to edit6 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit6 as text
%        str2double(get(hObject,'String')) returns contents of edit6 as a double


% --- Executes during object creation, after setting all properties.
function edit6_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit6 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end



function edit7_Callback(hObject, eventdata, handles)
% hObject    handle to edit7 (see GCBO)
```

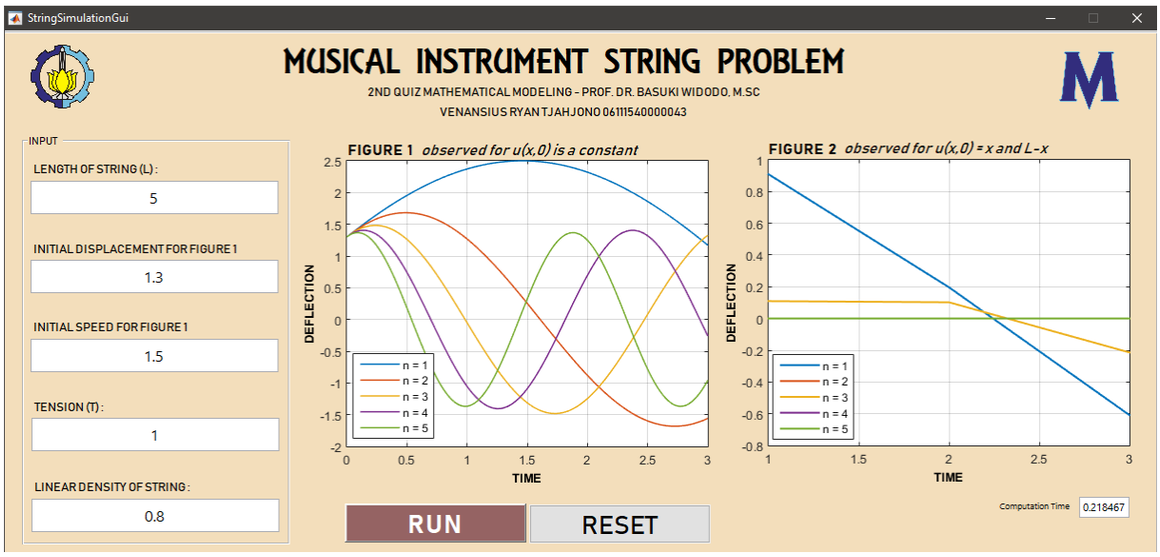
```
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of edit7 as text
%        str2double(get(hObject,'String')) returns contents of edit7 as a double


% --- Executes during object creation, after setting all properties.
function edit7_CreateFcn(hObject, eventdata, handles)
% hObject    handle to edit7 (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
    set(hObject,'BackgroundColor','white');
end
```

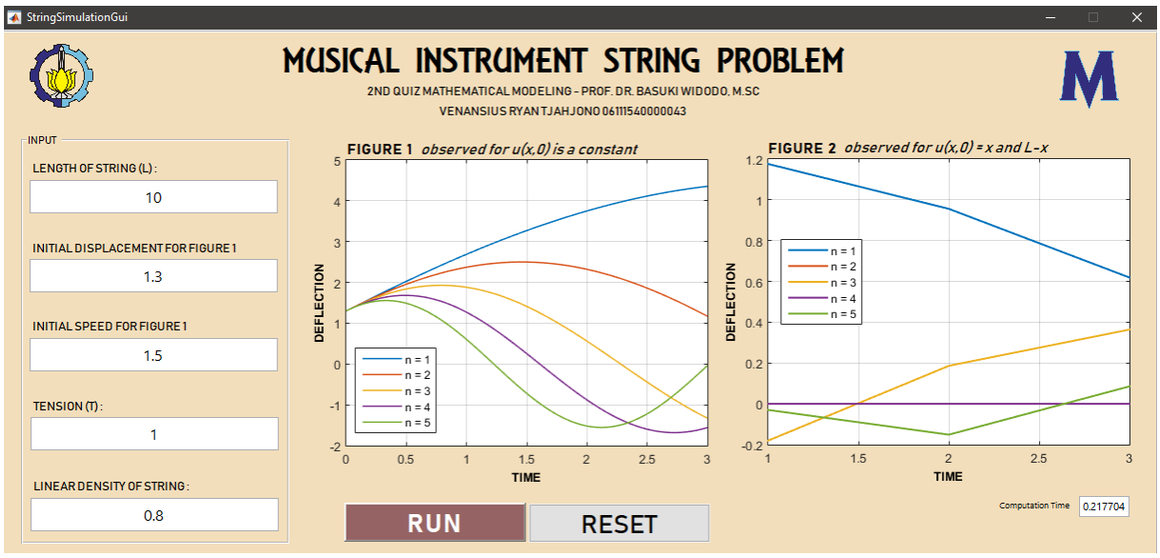


GRAPHICAL USER INTERFACE

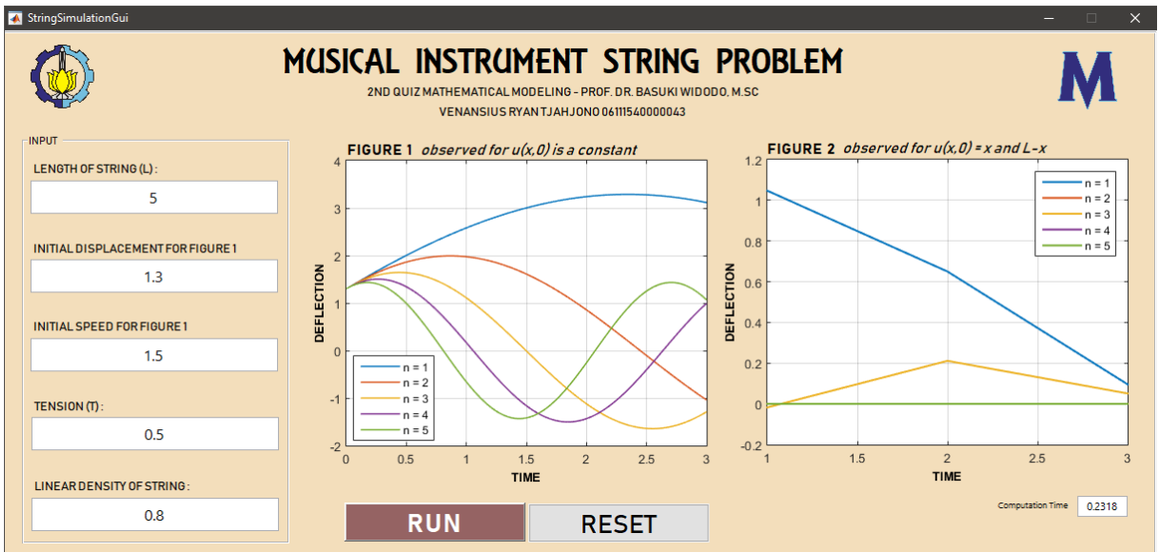
SIMULATION RESULT FOR VARIOUS LENGTH

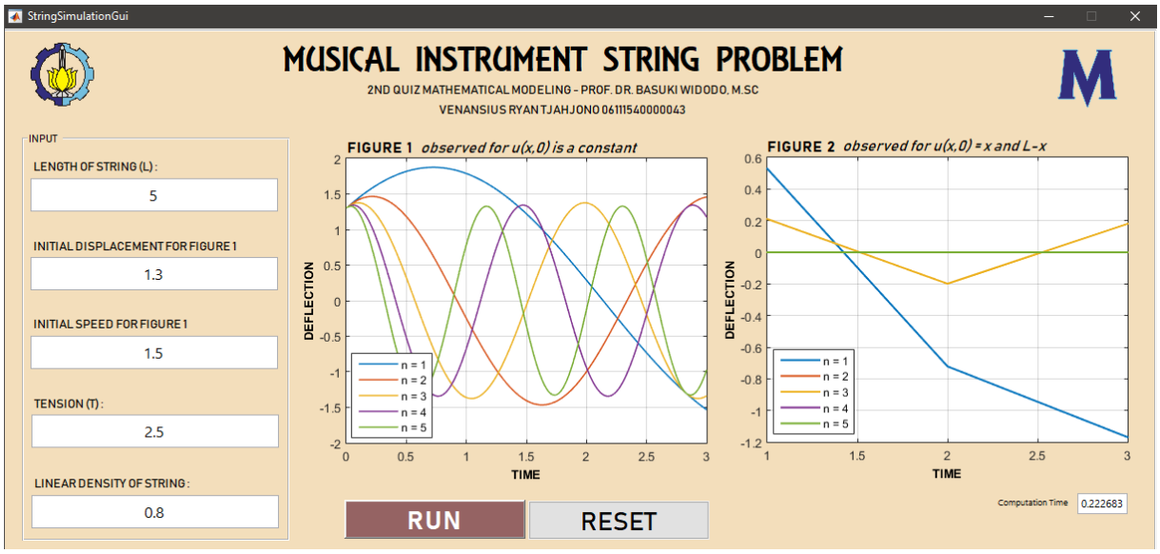


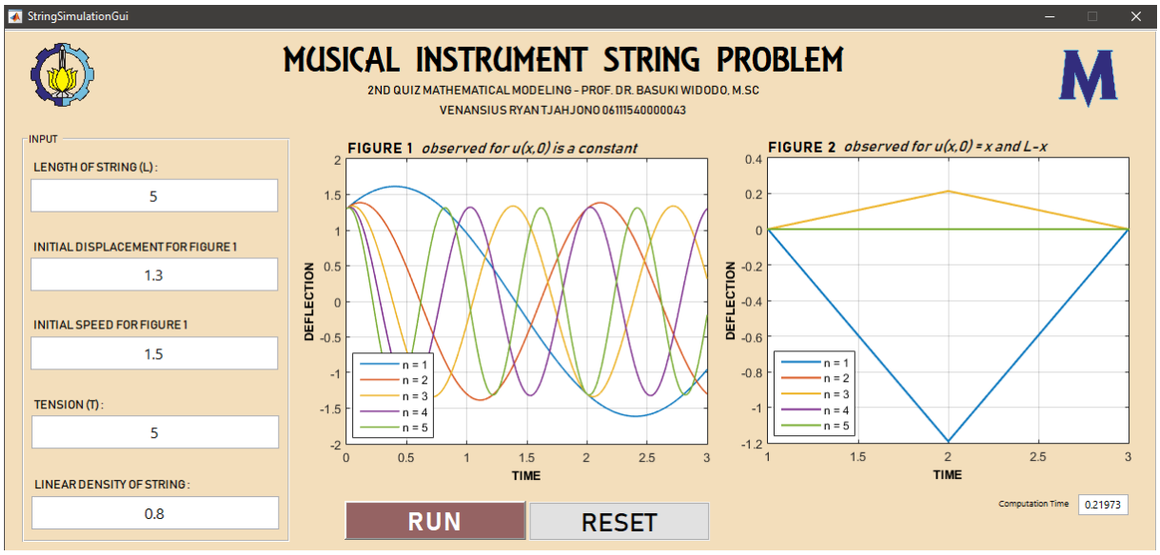




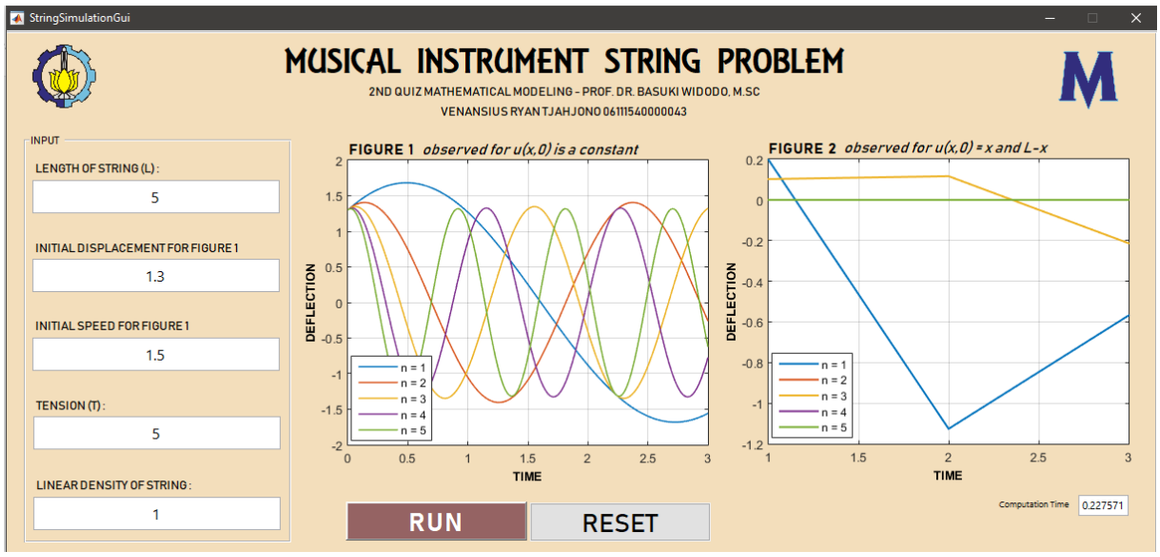
SIMULATION RESULT FOR VARIOUS TENSION

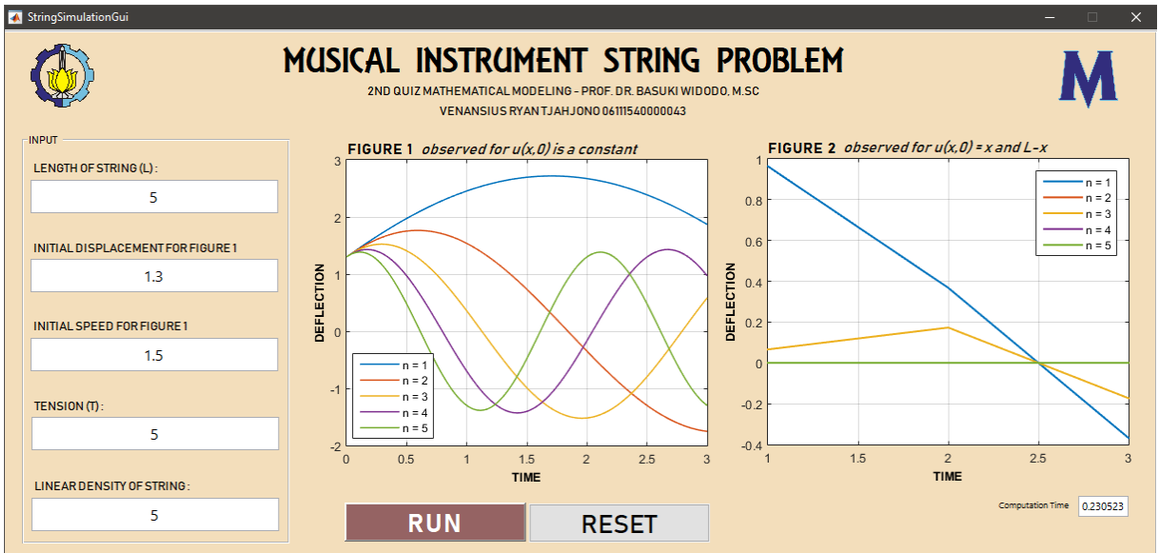


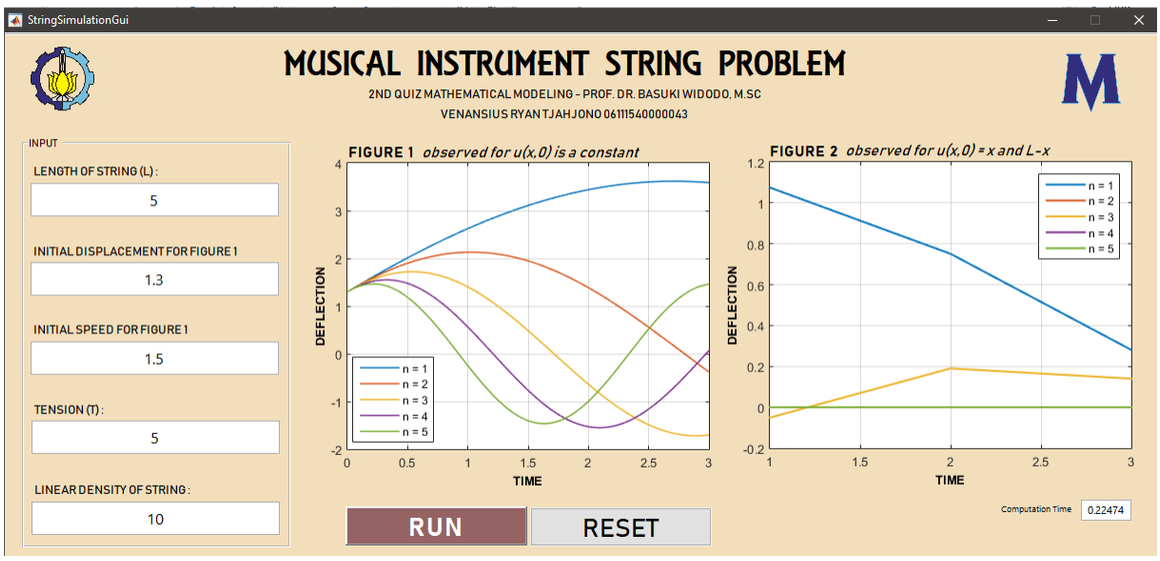




SIMULATION RESULT FOR VARIOUS LINEAR DENSITY (OR UNIT MASS/LENGTH)







CONCLUSION

Wave patterns are produced by musical instrument string, as the result of the repeated interference of two waves of identical frequency while moving in opposite directions along the same medium. Most of musical instrument wave patterns consist of nodes and antinodes. Based to my simulation, it can be shown that:

1. Longer string cause decreasing frequency.
2. Bigger tension produces bigger frequency.
3. Bigger linear density produces lower frequency.