Bridge circuits

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This code was developed by Miodrag Bolic for the book PERVASIVE CARDIAC AND RESPIRATORY MONITORING DEVICES: https://github.com/Health-Devices/CARDIAC-RESPIRATORY-MONITORING

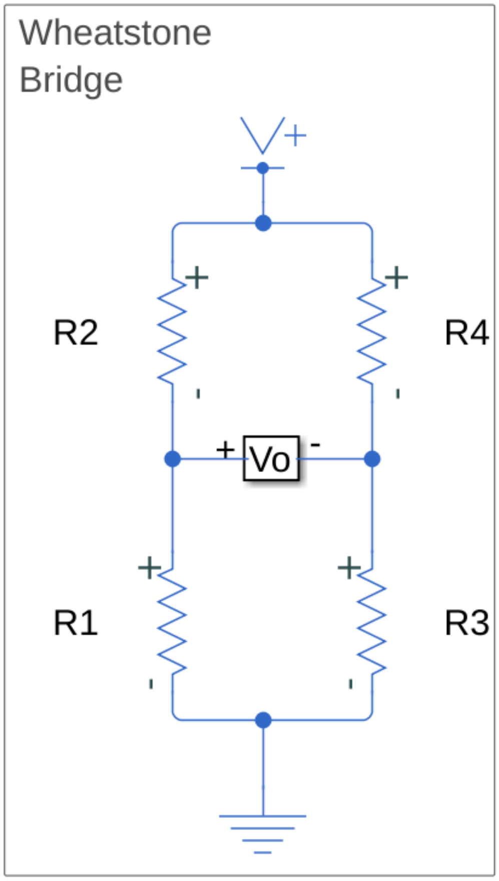
```
% Changing the path from main_folder to a particular chapter
main_path=fileparts(which('Main_Content.mlx'));
if ~isempty(main_path)
    %addpath(append(main_path,'/Chapter2'))
    cd (append(main_path,'/Chapter3/Bridges'))
    addpath(append(main_path,'/Service'))
end
SAVE_FLAG=0; % saving the figures in a file
```

Introduction

In this notebook, we will introduce the bridge circuit, and show how to connect it to the instrumentation amplifier and how to linearize it.

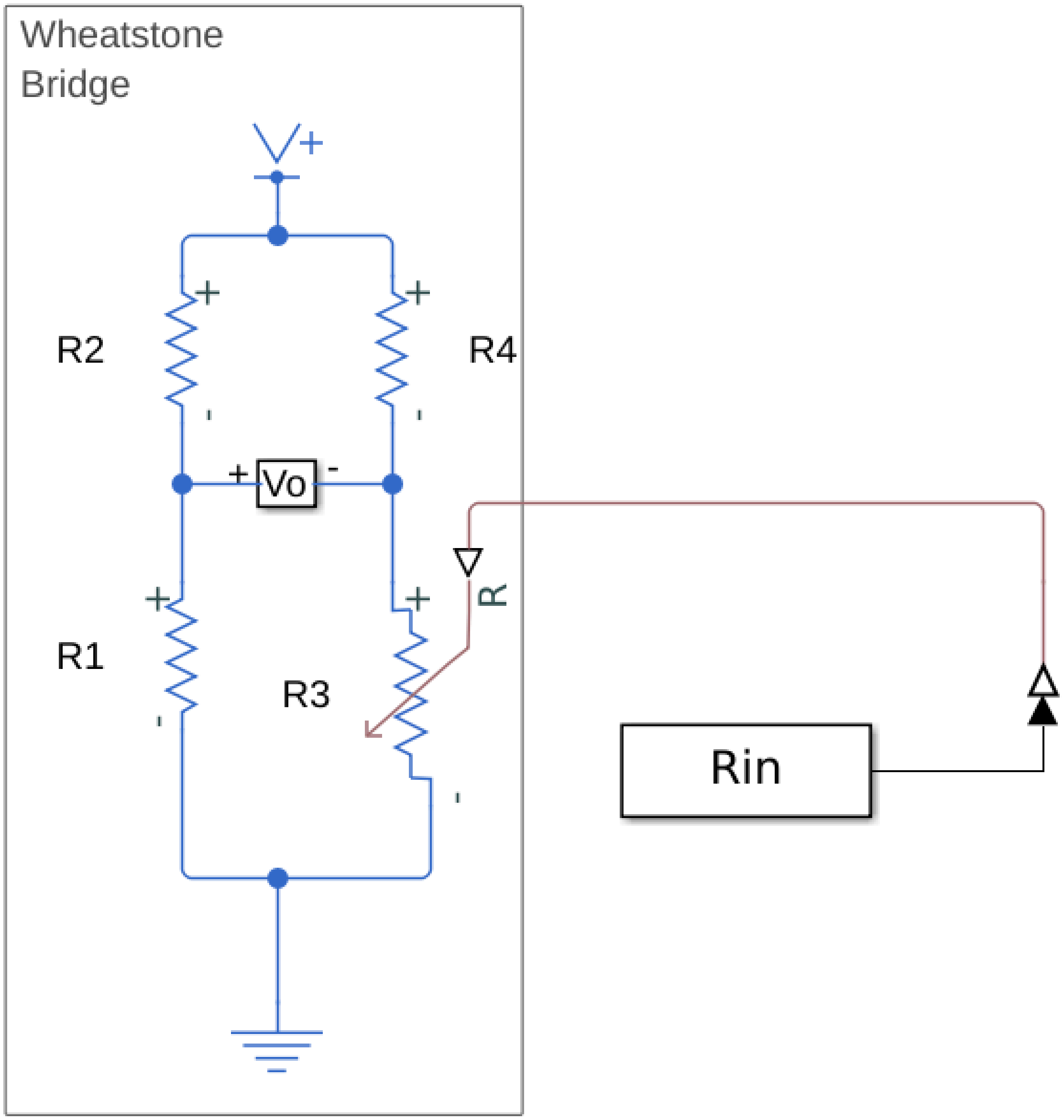
Bridge circuit

Bridge circuit is show for the figure below. The outout is shown when the resistor R3 changed its value from in the range of 3%.



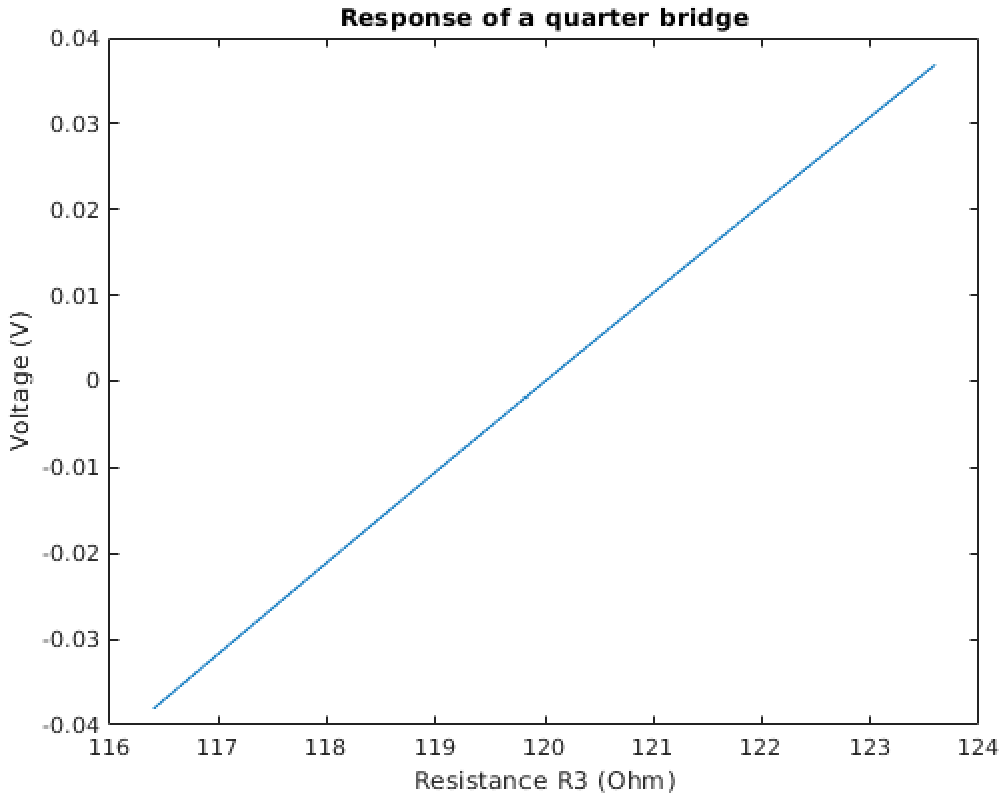
```
% Balanced bridge
model_name = 'bridge1';
open_system(model_name);
set_param('bridge1/R1','R','120');
set_param('bridge1/R2','R','120');
set_param('bridge1/R3','R','120');
set_param('bridge1/R4','R','120');
simOut = sim('bridge1', 'CaptureErrors', 'on');
```

Quarter bridge

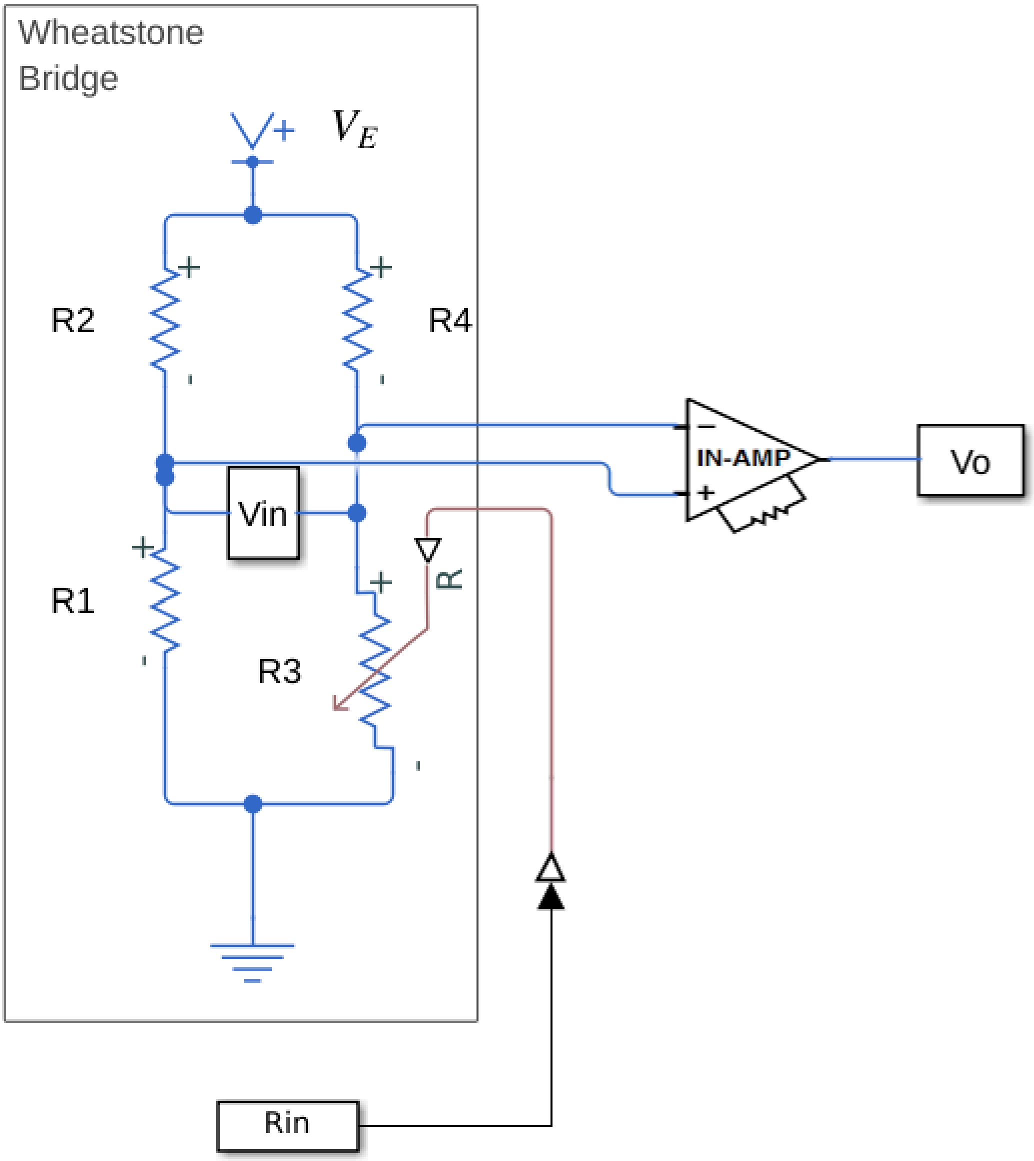


```
% Changing input resistance of R3 over 2 sec from 120Ohm -3% to 120 +3%
T=0.001;
Rin(:,1)=T:T:2; %time;
percentage_change=3;
R_nominal=120;
R_range=[R_nominal-R_nominal*percentage_change/100, R_nominal+R_nominal*percentage_char
deltaR=(R_range(2)-R_range(1))/length(Rin(:,1));
Rin(:,2)=R_range(1):deltaR:R_range(2)-deltaR;
```

```
%Quarter bridge
model_name = 'quarter_bridge';
open_system(model_name);
set_param('quarter_bridge/R1','R','120');
set_param('quarter_bridge/R2','R','120');
set_param('quarter_bridge/R4','R','120');
simOut1 = sim('quarter_bridge', 'CaptureErrors', 'on');

figure
plot(Rin(:,2),simOut1.voltage_out.Data(1:length(Rin(:,2)),1))
title('Response of a quarter bridge')
xlabel('Resistance R3 (Ohm)')
ylabel('Voltage (V)')
```



Quarter bridge with the instrumentation amplifier

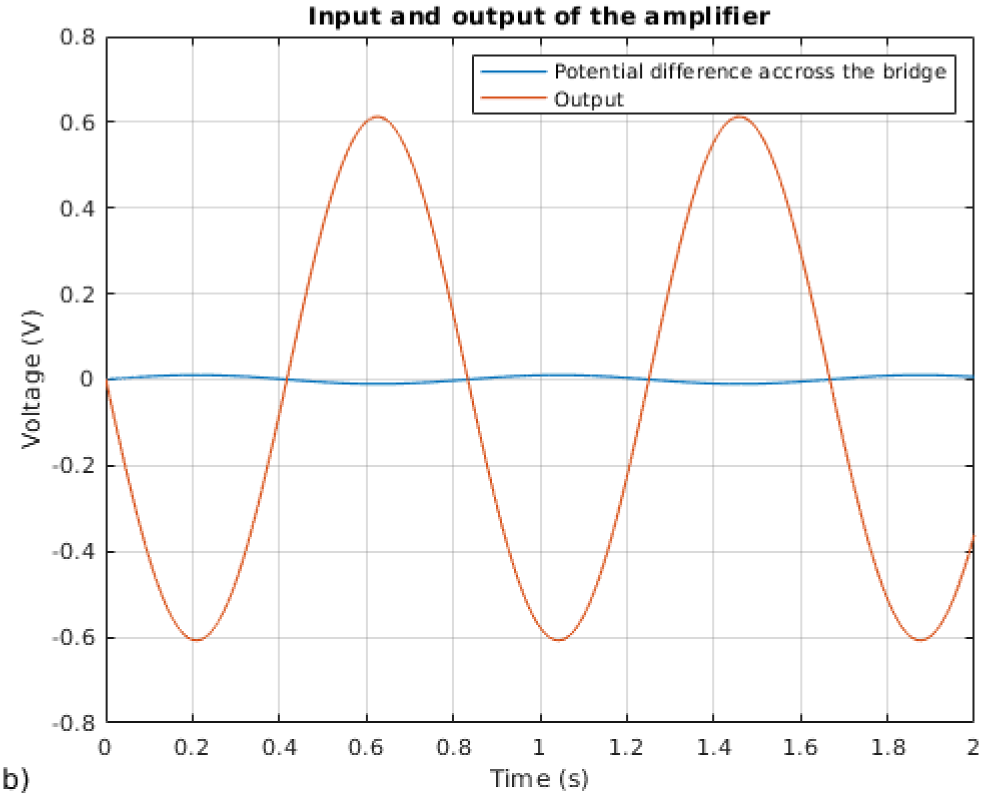


```
T=0.001;
t=T:T:2;
Rin(:,1)= t; %time;
percentage_change=3;
R_nominal=120;

Rin(:,2)=R_nominal+sin(2*pi*1.2*t);
```

```
%Quarter bridge
% Get simulation results
model_name = 'quarter_bridge_with_IA';
open_system(model_name);
set_param('quarter_bridge_with_IA/R1','R','120');
set_param('quarter_bridge_with_IA/R2','R','120');
set_param('quarter_bridge_with_IA/R4','R','120');
out=sim(model_name)
```

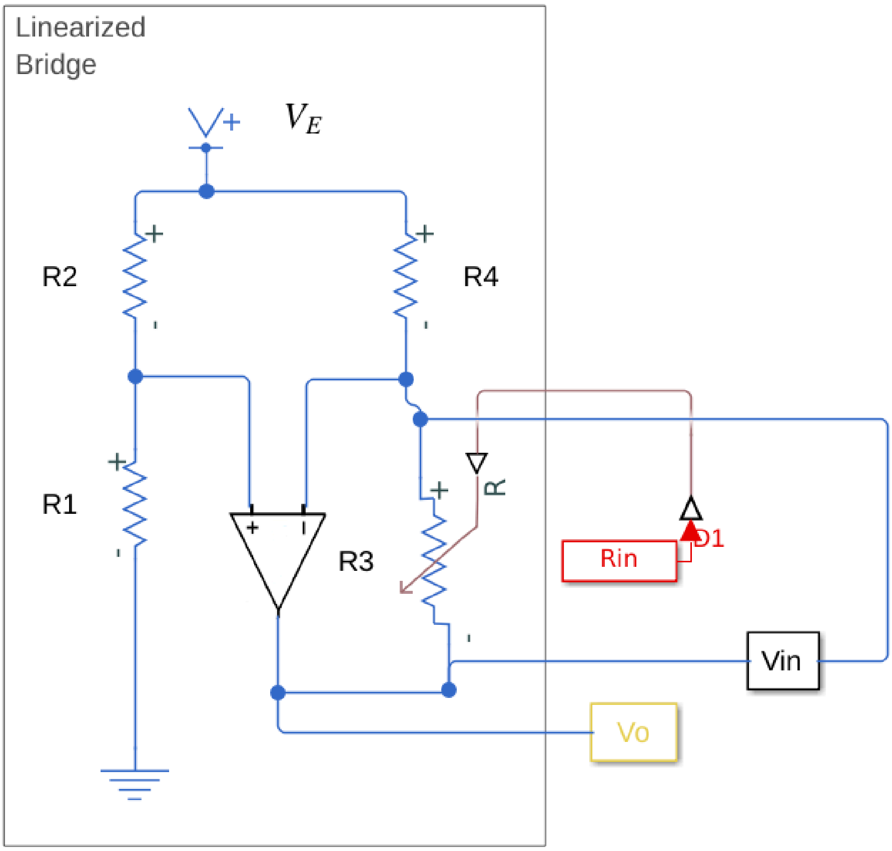
```
out = 
  Simulink.SimulationOutput:

                ScopeData: [1x1 struct] 
                  logsout: [1x1 Simulink.SimulationData.Dataset] 
                   simout: [1x1 timeseries] 
                     tout: [6126x1 double] 

     SimulationMetadata: [1x1 Simulink.SimulationMetadata] 
           ErrorMessage: [0x0 char] 
```

```
temp_vin = out.simout.Data(:,1);
temp_vout = out.simout.Data(:,2);

% Plot results
figure
plot(out.simout.Time,temp_vin,'LineWidth',1);
hold on
plot(out.simout.Time,temp_vout,'LineWidth',1);
hold off
grid on
title('Input and output of the amplifier');
ylabel('Voltage (V)');
xlabel('Time (s)');
xlim([0,2])
legend({'Potential difference accross the bridge','Output'});
annonation_save('b)',"Fig3.7b.jpg", SAVE_FLAG);
```



b)

Linearized quarter bridge



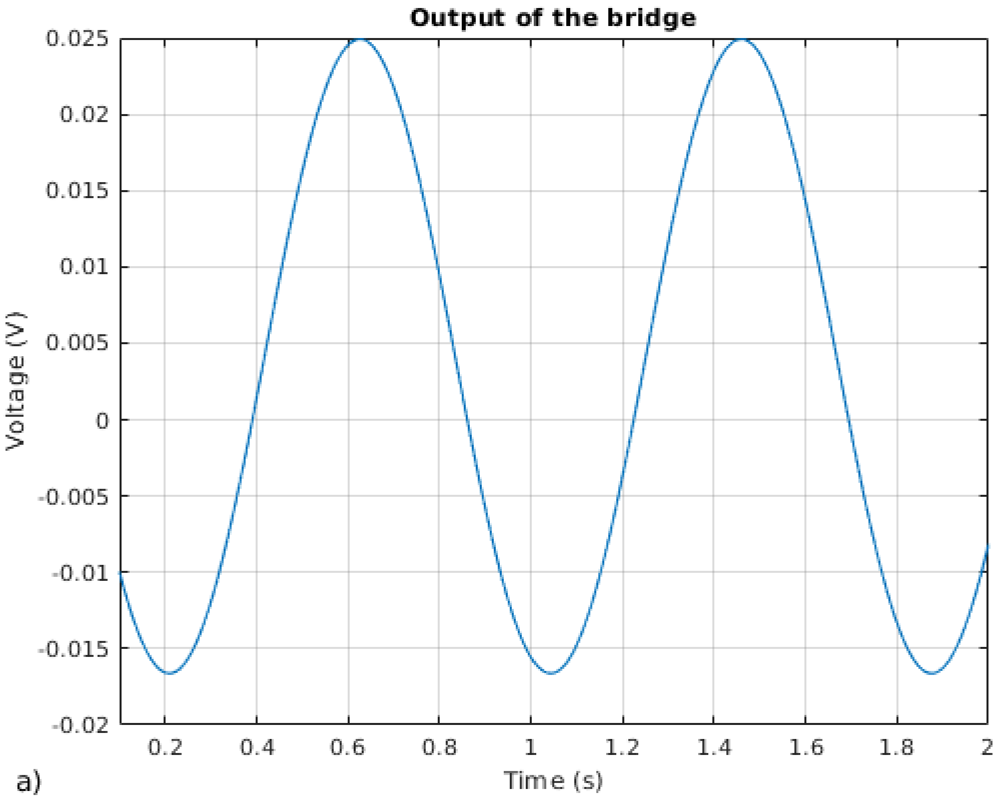
```
% Changing input resistance of R3 over 2 sec from 120Ohm -3% to 120 +3%
T=0.001;
t=T:T:2;
Rin(:,1)=T:T:2; %time;
percentage_change=3;
R_nominal=120;

Rin(:,2)=R_nominal+sin(2*pi*1.2*t);
```

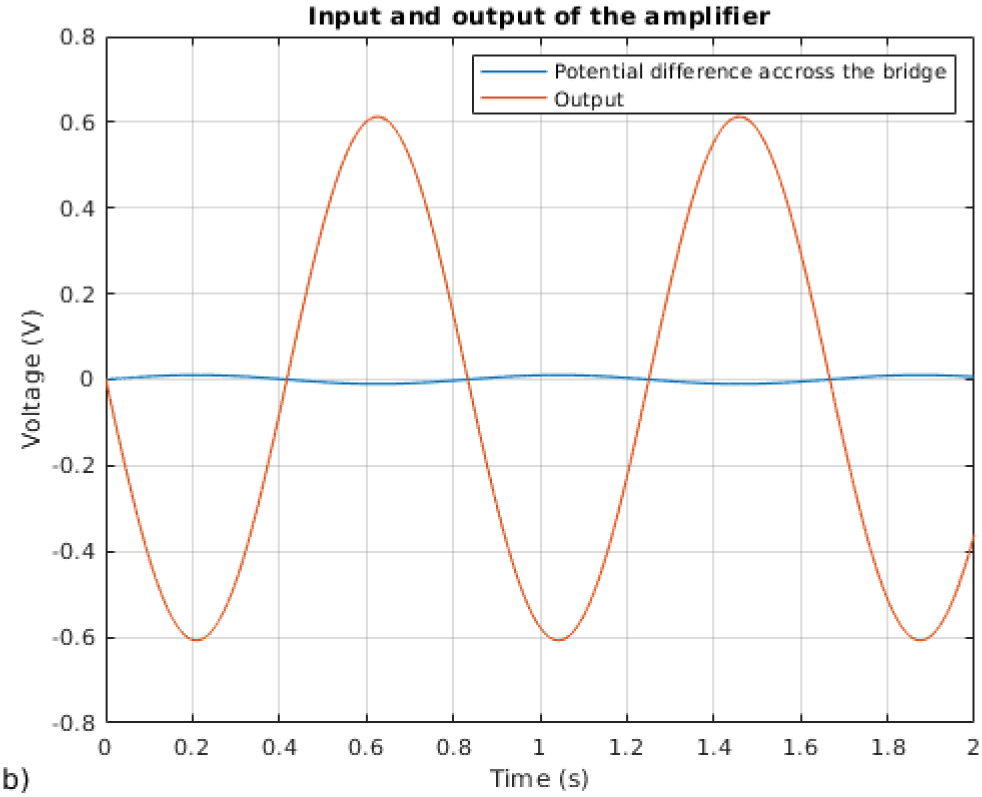
```
model_name = 'LinearizedBridge';
out=sim(model_name)
```

```
out = 
  Simulink.SimulationOutput:

                ScopeData: [1x1 struct] 
                  logsout: [1x1 Simulink.SimulationData.Dataset] 
                   simout: [1x1 timeseries] 
                     tout: [5932x1 double] 

     SimulationMetadata: [1x1 Simulink.SimulationMetadata] 
           ErrorMessage: [0x0 char] 
```

```
temp_vin = out.simout.Data(:,1);
temp_vout = out.simout.Data(:,2);
```

```
% Plot results
figure
%plot(out.simout.Time,temp_vin,'LineWidth',1);
%hold on
plot(out.simout.Time,temp_vout,'LineWidth',1);
hold off
grid on
title('Output of the bridge');
ylabel('Voltage (V)');
xlabel('Time (s)');
xlim([0.1,2])
annonation_save('a)',"Fig3.9a.jpg", SAVE_FLAG);
```





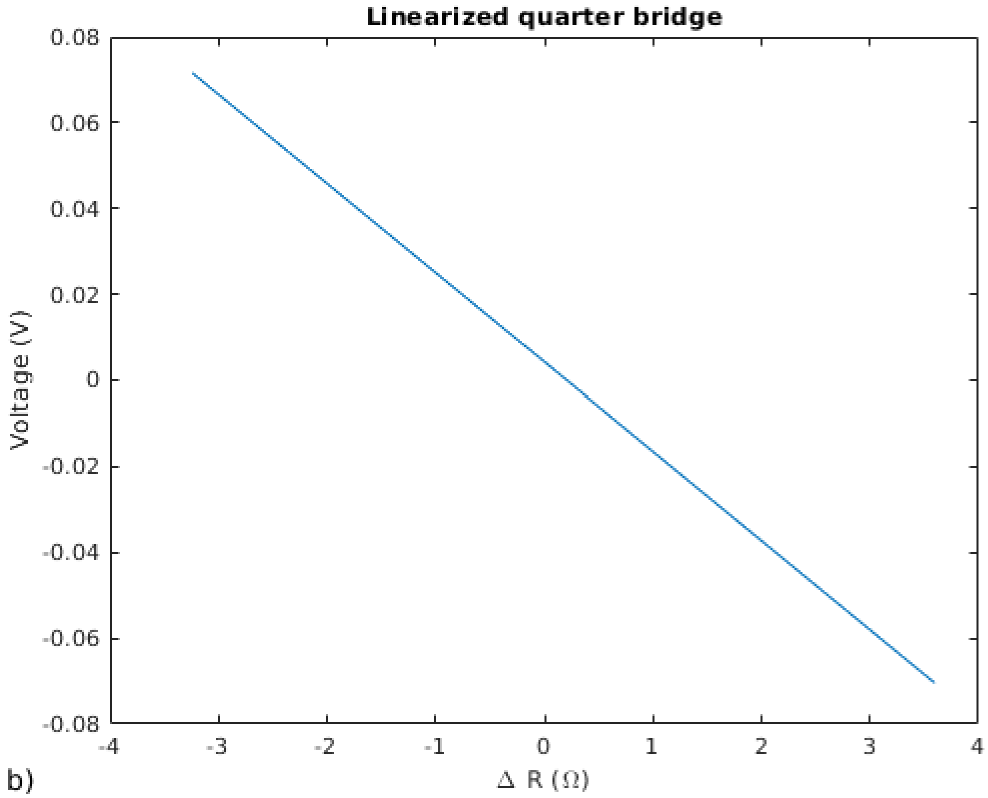
b)

```
%ylim([-0.1,0.1])
%legend({'Voltage over the bridge','Output'});

R_range=[R_nominal-R_nominal*percentage_change/100, R_nominal+R_nominal*percentage_char
deltaR=(R_range(2)-R_range(1))/length(Rin(:,1));
Rin(:,2)=R_range(1):deltaR:R_range(2)-deltaR;

out=sim(model_name)
```

```
out = 
  Simulink.SimulationOutput:

                ScopeData: [1x1 struct] 
                  logsout: [1x1 Simulink.SimulationData.Dataset] 
                   simout: [1x1 timeseries] 
                     tout: [6006x1 double] 

     SimulationMetadata: [1x1 Simulink.SimulationMetadata] 
           ErrorMessage: [0x0 char] 
```

```
temp_vin = out.simout.Data(:,1);
temp_vout = out.simout.Data(:,2);

% Plot results
figure

figure
plot(Rin(100:end,2)-R_nominal,temp_vout(100:end-1))
title('Linearized quarter bridge')
xlabel('\Delta R (\Omega)')
```

```
ylabel('Voltage (V)')
annonation_save('b)',"Fig3.9b.jpg", SAVE_FLAG);
```



Exersizes

Excersize 1: What is the Sensitivity of the quarter bridge if the sensitivity is computed as range of the output voltages/reference voltage?