UNIVERSITY COLLEGE LONDON

MENG MECHANICAL ENGINEERING

MECH0071 ELECTRICAL POWER SYSTEMS AND ELECTRICAL PROPULSION

PSCAD COURSEWORK

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1.1 Circuit diagram

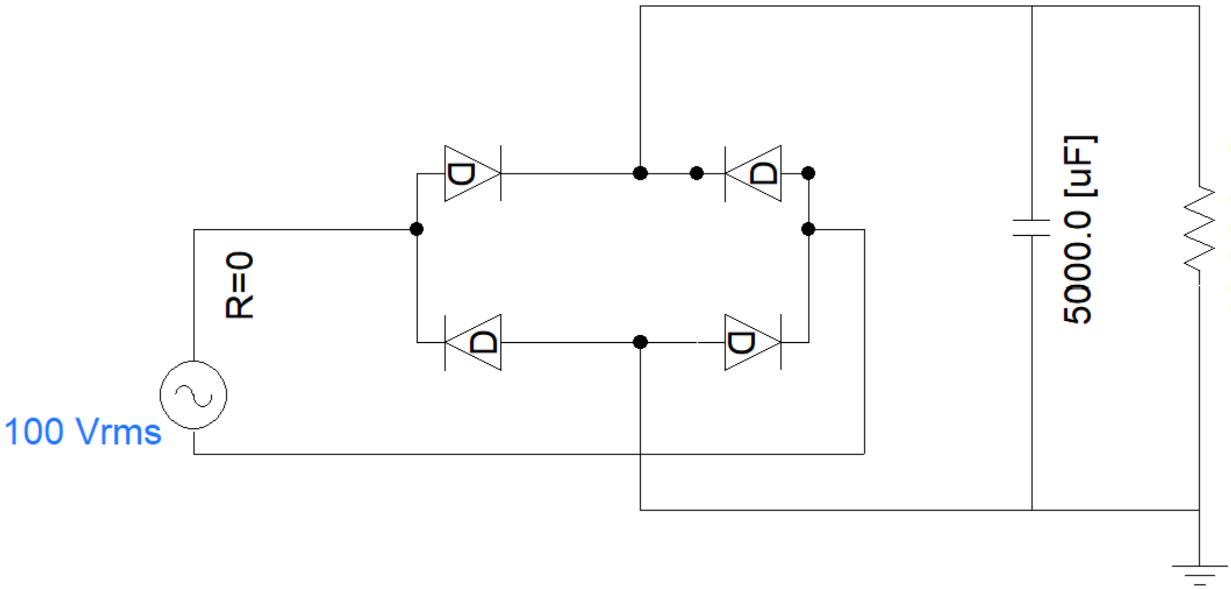

Figure 1: Circuit diagram to show diode bridge circuit.

1.2 Instantaneous voltages

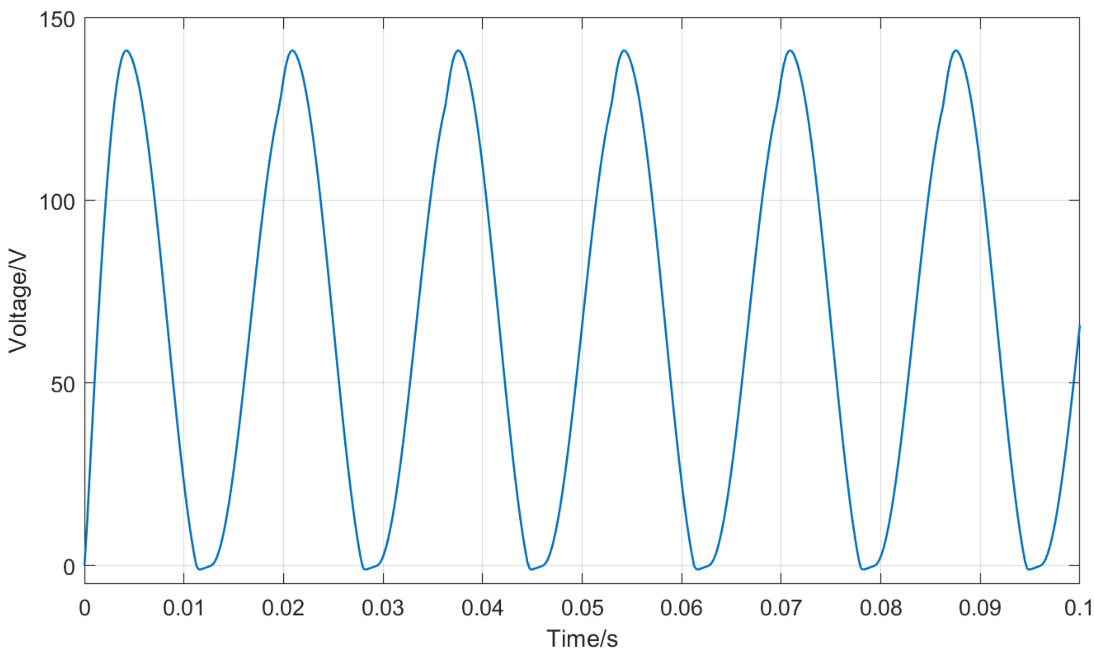

Figure 2: Graph to show instantaneous input voltage across the voltage source.

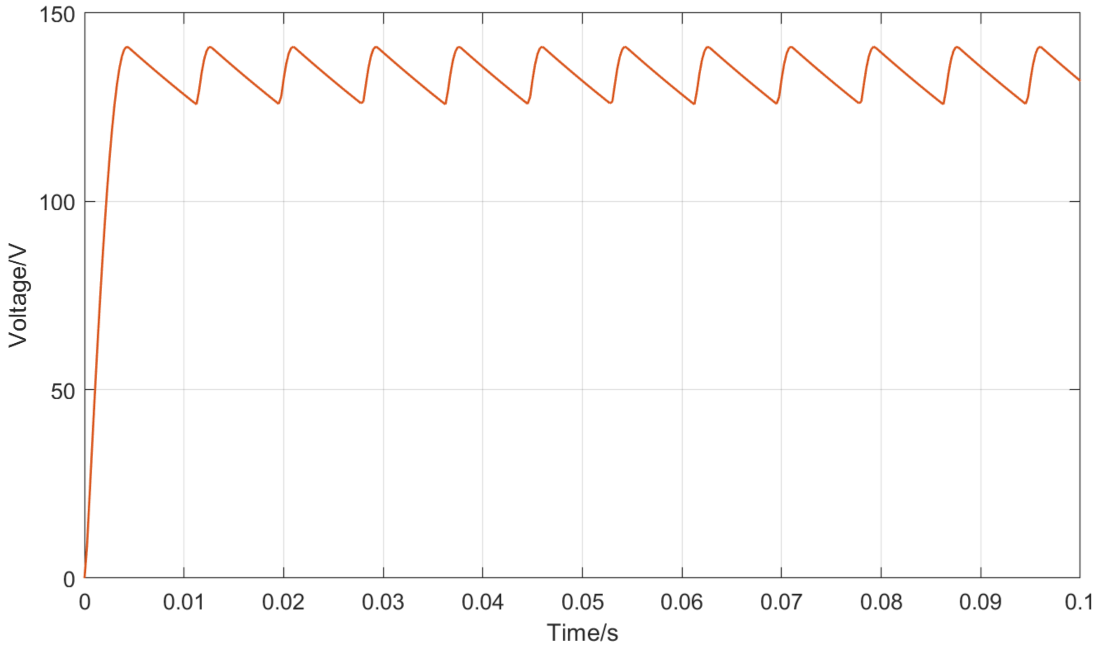

Figure 3: Graph to show instantaneous output voltage across the resistive load.

1.3 Effect of increasing capacitcance to $25\,\mu\mathrm{F}$

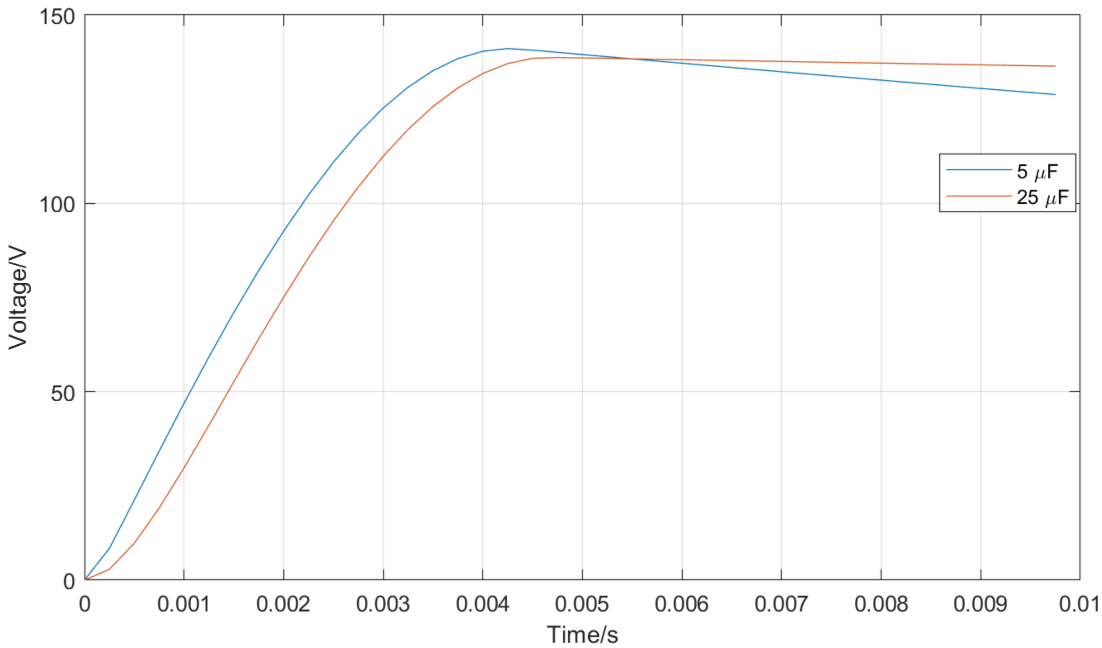

Figure 4: Graph to show comparison between instantaneous output voltage across the resistive load for different capacitance values.

The purpose of the capacitor in this diode bridge circuit is to filter/reduce the amount of voltage ripple, inherent to bridge diode circuits. We can see in Figure 3 that our voltage drop is approximately $25\,\mathrm{V}$ between pulses ($5\,\mu\mathrm{F}$). By increasing the capacitance, our voltage drop reduces (from data: voltage drop with $25\,\mu\mathrm{F} \approx 4\,\mathrm{V}$.) This is desirable as this achieves a more stable DC output. However, increasing the capacitance also increases the rise time and reduces the peak voltage of the output, shown in Figure 4.

2 Equivalent transformer

2.1 Circuit diagram

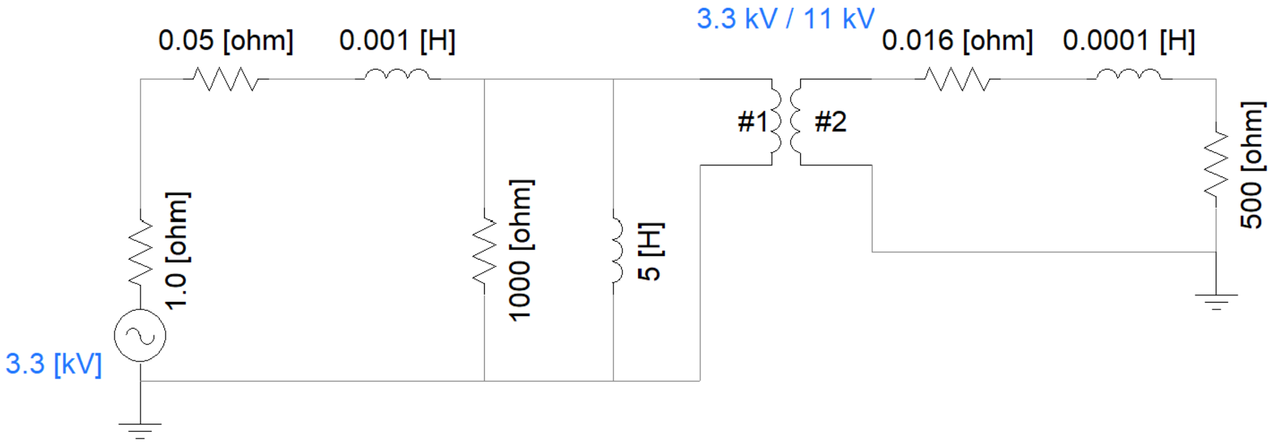

Figure 5: Circuit diagram to show equivalent transformer.

2.2 Resistive load

2.2.1 RMS Voltage

The RMS voltage can be calculated using (1).

$$V_{RMS} = \sqrt{\frac{\sum_{i=1}^{n} x_i^2}{n}} \tag{1}$$

- Simulation time: $0.5\,\mathrm{s}$
- Number of data points (n): 2002

Using MATLAB:

$$V_{RMS,r} = 10.14\,\mathrm{kV} \tag{2}$$

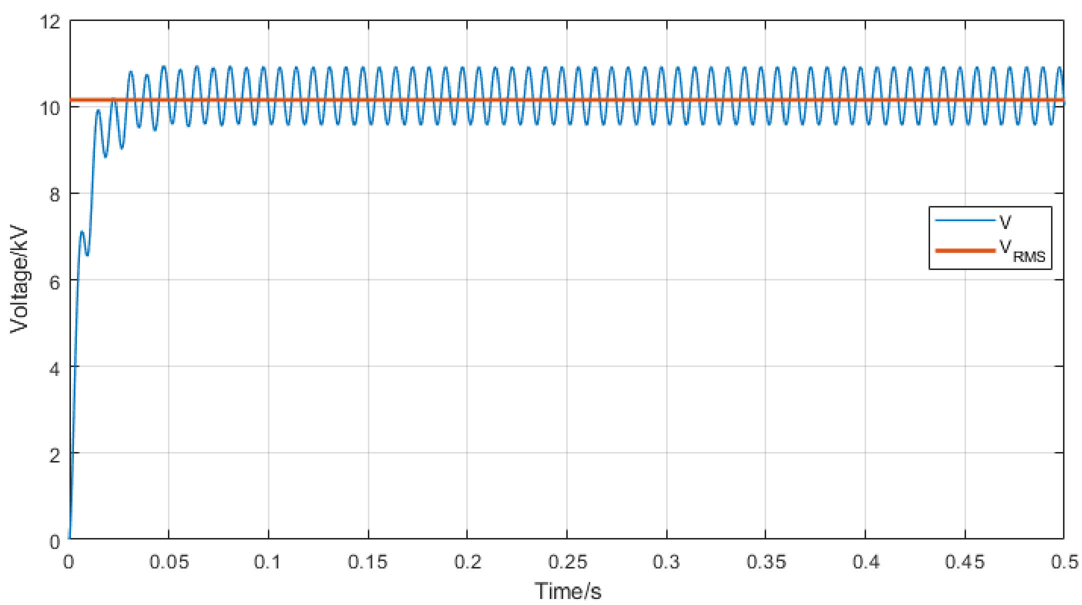

Figure 6: Voltage across load over time and value of $V_{RMS,r}$.

(see Appendix A.2)

2.2.2 Power factor

The power factor can be calculated using the following equation:

$$PF = \cos\phi \tag{3}$$

Using MATLAB, the converged value of the power factor was found by averaging the final values in the dataset.

$$PF_r = 0.995 \tag{4}$$

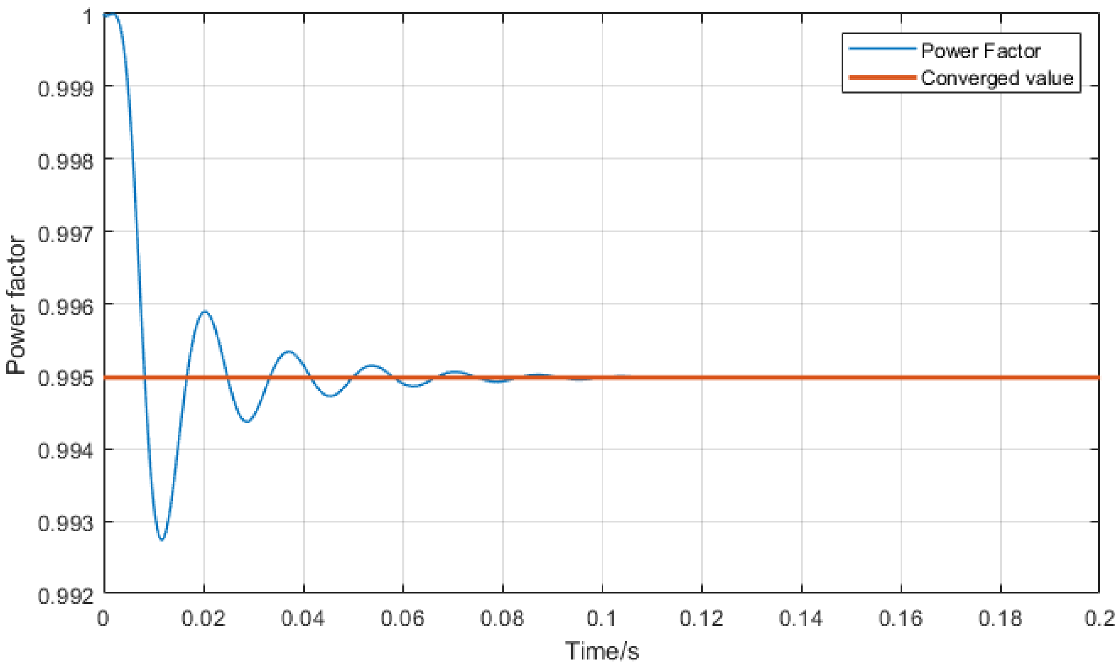

Figure 7: Power factor over time (resistor).

(see Appendix A.2).

2.3 Inductive load

2.3.1 RMS Voltage across the load

Using MATLAB:

$$V_{RMS,i} = 2.79\,\text{kV} \tag{5}$$

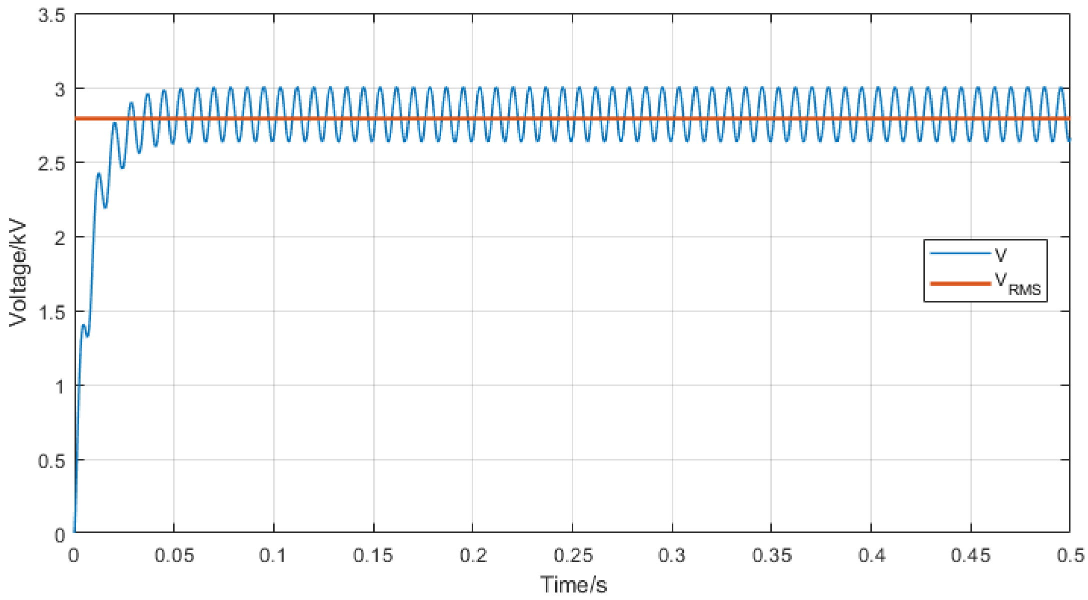

Figure 8: Voltage across load over time and value of $V_{RMS,i}$.

(see Appendix A.2)

2.3.2 Power factor across the load

Using MATLAB:

$$PF_i = 0.563 \tag{6}$$

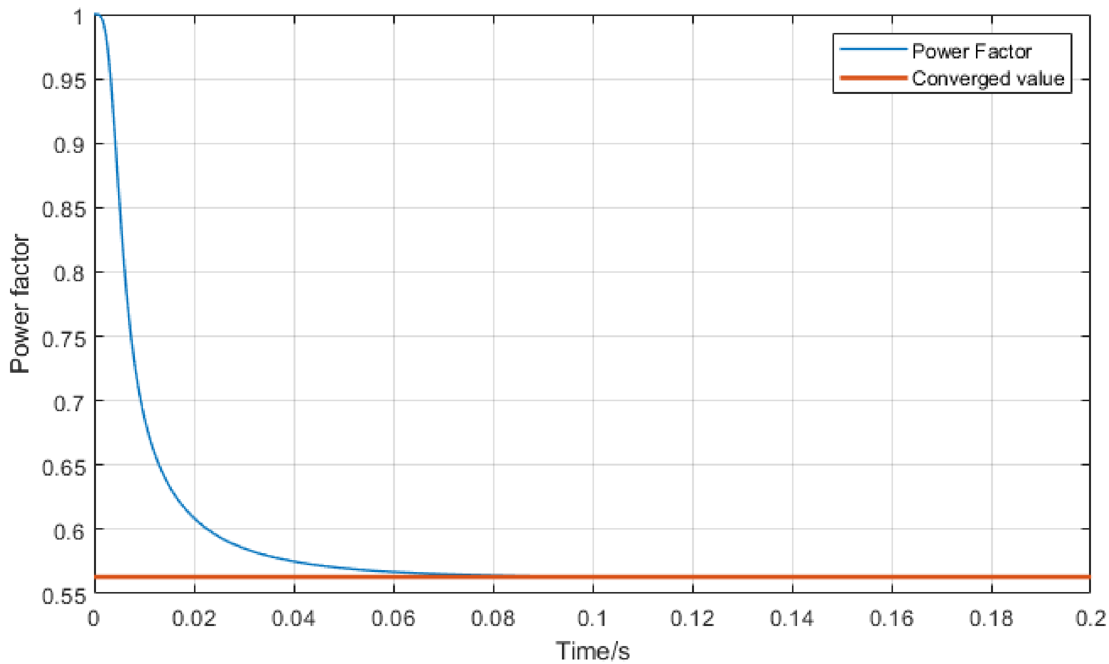

Figure 9: Power factor over time (inductor).

(see Appendix A.2).

2.4 Capacitive load

2.4.1 RMS Voltage

Using MATLAB:

$$V_{RMS,c} = 0.262\,\mathrm{kV} \tag{7}$$

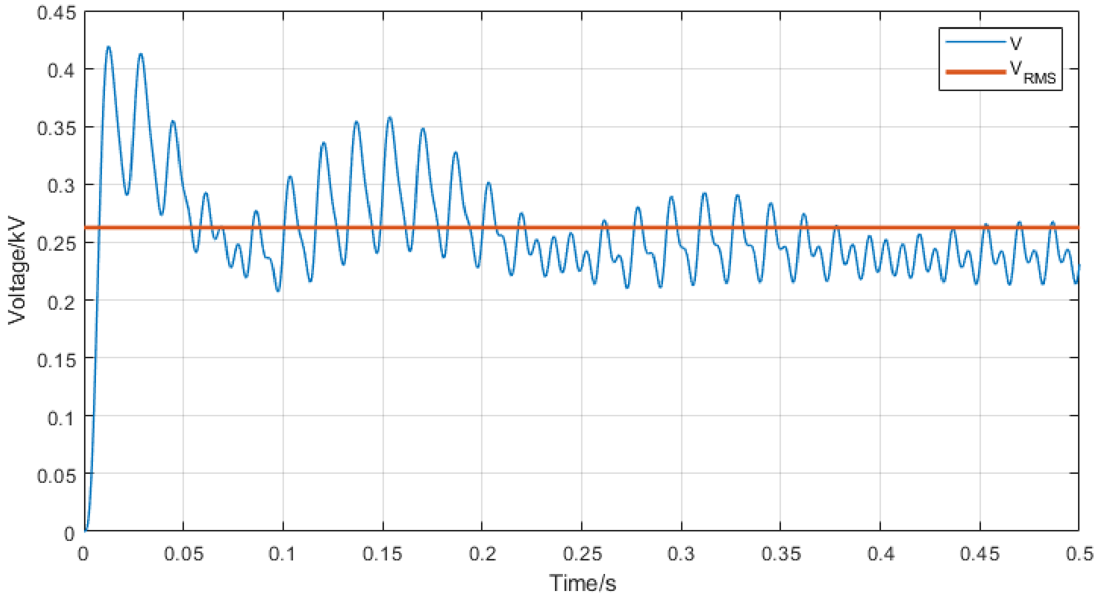

Figure 10: Voltage across load over time and value of $V_{RMS,c}$.

(see Appendix A.2)

2.4.2 Power factor

Using MATLAB:

$$PF_c = -0.328 \tag{8}$$

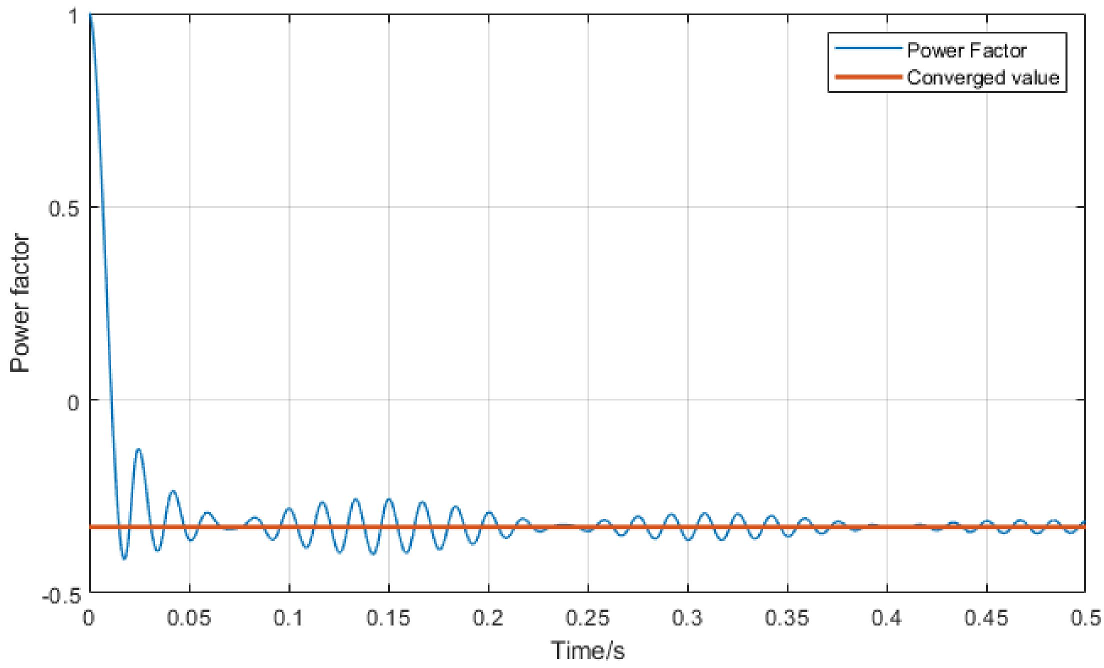

Figure 11: Power factor over time (capacitor).

(see Appendix A.2).

A MATLAB code

A.1 Question 1

```
%HD
clc
clear

%import data
data = readmatrix('dataimport.xlsx','Sheet','q1');

%datasets
VSource = cat(2,data(:,5),data(:,6));
VResistor = cat(2,data(:,7),data(:,8));
VResistor2 = cat(2,data(:,9),data(:,10));

%graph plots
%plot(VResistor2(:,1),VResistor2(:,2),'LineWidth',1,'color',[0.4940 0.1840
    0.5560])
plot(VResistor(1:40,1),VResistor(1:40,2),VResistor2(1:40,1),VResistor2(1:40,2))
grid on
axis 'auto xy'
xlim([0,0.01])
ylim([0,150])
xlabel('Time/s')
ylabel('Voltage/V')
legend('5 {\mu}F','25 {\mu}F')

%'color',[0.4940 0.1840 0.5560]
```

A.2 Question 2

```
%HD
clc
clear

%import data
data = readmatrix('dataImport.xlsx','Sheet','table2');
data2 = readmatrix('dataImport.xlsx','Sheet','table2.2');

%datasets
VResistor = cat(2,data(:,1),data(:,2));
PhaseResistor = cat(2,data(:,3),data(:,4));
VInductor = cat(2,data2(:,1),data2(:,2));
PhaseInductor = cat(2,data2(:,3),data2(:,4));
VCapacitor = cat(2,data2(:,5),data2(:,6));
PhaseCapacitor = cat(2,data2(:,7),data2(:,8));

%VRMS
VSq1 = VResistor(:,2).^2;
VRMSResistor = sqrt(sum(VSq1)/numel(VSq1));

VSq2 = VInductor(:,2).^2;
VRMSInductor = sqrt(sum(VSq2)/numel(VSq2));

VSq3 = VCapacitor(:,2).^2;
VRMSCapacitor = sqrt(sum(VSq3)/numel(VSq3));

%PF
```

```
averagePFResistor =
    cos(mean(PhaseResistor(0.8*numel(PhaseResistor(:,1)):end,2)));
PFResistor = cos(PhaseResistor(:,2));

averagePFInductor =
    cos(mean(PhaseInductor(0.8*numel(PhaseInductor(:,1)):end,2)));
PFInductor = cos(PhaseInductor(:,2));

averagePFCapacitor =
    cos(mean(PhaseCapacitor(0.8*numel(PhaseCapacitor(:,1)):end,2)));
PFCapacitor = cos(PhaseCapacitor(:,2));

%graph plotting
%{
plot(VCapacitor(:,1),VCapacitor(:,2),...
   VCapacitor(:,1),linspace(VRMSCapacitor,VRMSCapacitor,numel(VCapacitor(:,1))))
grid on
axis 'auto xy'
xlim([0,0.5])
xlabel('Time/s')
ylabel('Voltage/kV')
legend('V','V_{RMS}')
%}

plot(PhaseResistor(:,1),PFResistor,PhaseResistor(:,1),...
   linspace(averagePFResistor,averagePFResistor,numel(PhaseResistor(:,1))))
grid on
axis 'auto xy'
xlim([0,0.2])
xlabel('Time/s')
ylabel('Power factor')
legend('Power Factor','Converged value')
```