Demonstration 2

Equations used from previous lectures

Rms value of a function

$$F_{rms} = \sqrt{\frac{1}{T}\int_0^T f(t)^2\,dt}$$

Average value of a function

$$F_{avg} = \frac{1}{T}\int_0^T f(t)dt$$

Power dissipation in a resistor

$$P = RI_{rms}^2$$

Power dissipation in a diode when it is conducting

If a diode is represented only by a forward voltage drop

$$P = V_f I_{avg}$$

If a diode is represented by a series resistance together with the forward voltage drop

$$P = V_f I_{avg} + R_{cond} I_{rms}^2$$

Literature: Undeland book Chapter 2

One of the phasor problem from demonstration 1

Problem 4 (P3-7 in Undeland book)

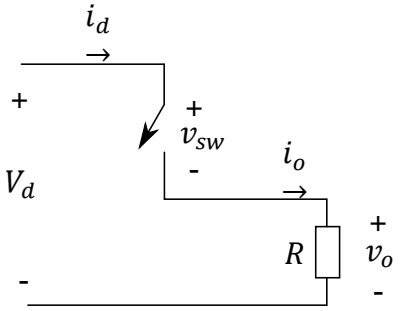
A three-phase inductive load is supplied from a voltage source with $V_{phase} = 120V$. The load draws 10kW with a power factor of 0.85 (lagging).

(a) Calculate the RMS-value of the phase currents and the magnitude of the phase impedance.
(b) Draw a phasor diagram.

Tutorial exercises

Problem 1

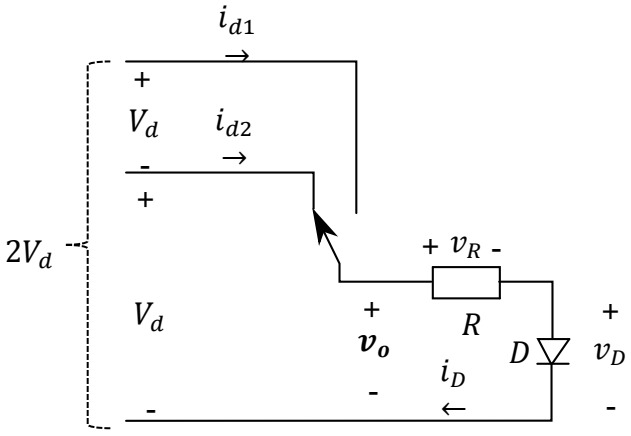
In the circuit below, the ideal switch is turned on and off with a duty cycle of D=0.6 at 20 kHz.



V_d= 15V
f_{sw}= 20 kHz
D = 0.6
R = 5 Ω

(a) Calculate the average output voltage V_o.
(b) Sketch the output current i_o.
(c) Calculate the average output current I_o.
(d) Calculate the power dissipation in the resistor R.

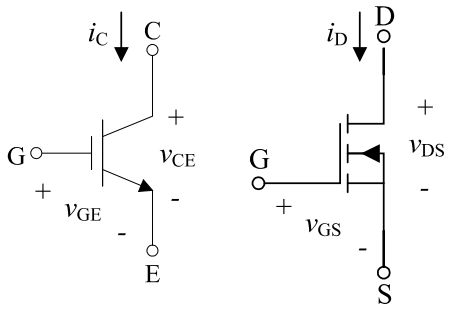
Problem 2



V_d= 15V
f_{sw}=20kHz
D = 0.6
R = 5 Ω
V_f = 0.82V (diode forward voltage drop)

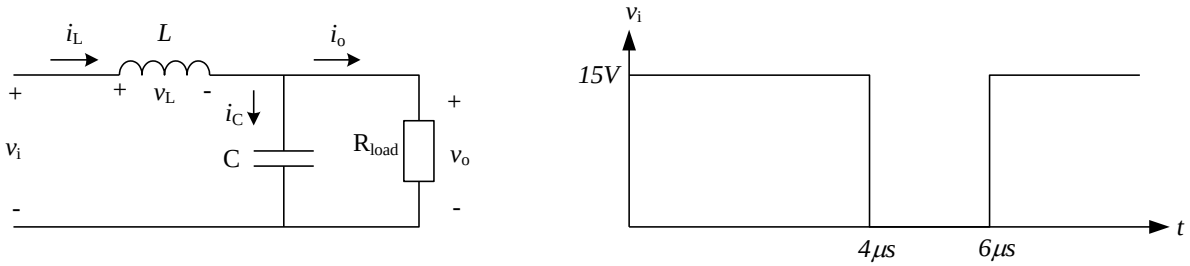
(a) Calculate the average diode voltage V_D.
(b) Sketch the diode current i_D.
(c) Calculate the average diode current I_D.
(d) Calculate the power dissipation in the diode D.

Problem 3



(a) Sketch the voltages (v_{CE} and v_{DS}) over the two switching devices as function of the current trough the devices (i_C and i_D).
(b) Derive a formula, for each switching device, that can be used to calculate its conduction losses.

Problem 4 (P3-8 in Undeland book)

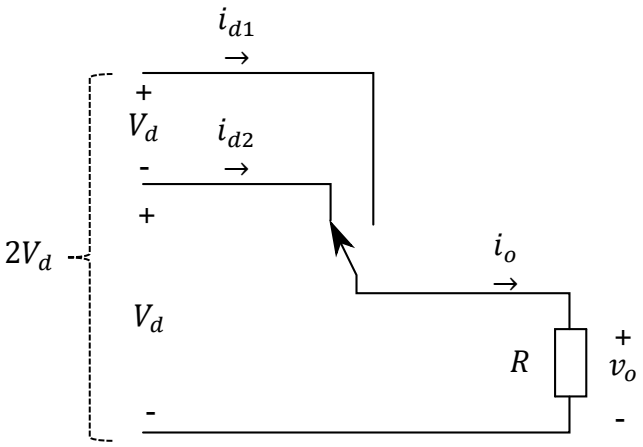


The applied voltage (v_i) is repetitive and the system is in steady state. Assume that the capacitance is very large, the inductor has a value of $L = 5\mu H$ and that the load consumes 250W (P_{load})

(a) Calculate the average output voltage V_o.
(b) Calculate the average output current and the rms-value of the capacitor current.

Problem 5

In the circuit below, the switch connects the resistor to the voltage, V_d, during the time interval $0 < t < DT$. The rest of the time period, T, it connects the resistor to the voltage $2V_d$.



V_d= 15V
f_{sw}= 20 kHz
D = 0.6
R = 5 Ω

(a) Calculate the average output voltage V_o.
(b) Sketch the output current i_o.
(c) Calculate the average output current I_o.
(d) Calculate the power dissipation in the resistor R.