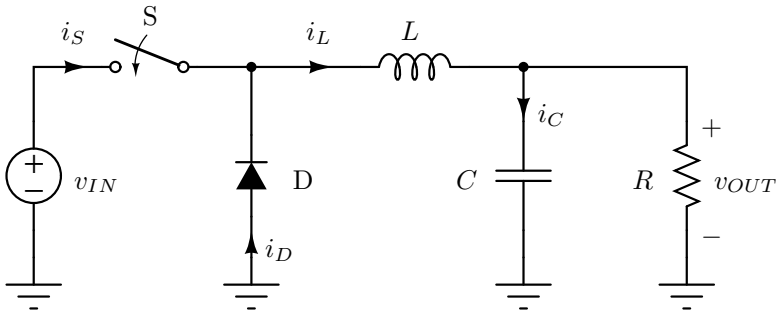
ENERGETSKA ELEKTRONIKA, kolokvijum 2013 **21.04.2013.**

1. U buck konvertoru sa slike 1 prekidač i dioda se mogu smatrati idealnim, $L = 12.5\,\mu\text{H}$, $C \to \infty$ ako se drugačije ne naglasi, $V_{IN} = 10\,\text{V}$. Konvertorom se upravlja tako što se sa frekvencijom $f_S = 100\,\text{kHz}$, na svakih $T_S = 10\,\mu\text{s}$, uključuje prekidač S, a isključuje se kada struja prekidača dostigne vrednost I_m. Sistem automatskog upravljanja podešava vrednost I_m tako da izlazni napon bude $V_{OUT} = 5\,\text{V}$.
a) [2] Za $R = 2.5\,\Omega$ odrediti I_m i nacrtati i označiti vremenske dijagrame v_L, i_L, i_S, i_D, i i_C.
b) [3] Za $R = 20\,\Omega$ odrediti I_m i nacrtati i označiti vremenske dijagrame v_L, i_L, i_S, i_D, i i_C.
c) [3] Za odrediti zavisnost $I_m\,(R)$ i nacrtati dijagram dobijene zavisnosti za $2.5\,\Omega \leq R \leq 20\,\Omega$.
d) [2] Za $R = 2.5\,\Omega$ i $C = 400\,\mu\text{F}$ odrediti funkciju prenosa $Z(s) = \hat{v}_{OUT}(s)/\hat{I}_m(s)$.



Slika 1

Preliminarno razmatranje, buck granica CCM i DCM, $I_0 = 0$, $D = V_{OUT}/V_{IN} = 0.5$,

$$I_1 = \frac{V_{IN} - V_{OUT}}{L}\,D\,T_S = 2\,\text{A}$$

$$I_{OUTcrit} = \frac{I_1}{2} = 1\,\text{A}$$

a)

$$I_{OUT} = \frac{5\,\text{V}}{2.5\,\Omega} = 2\,\text{A}$$

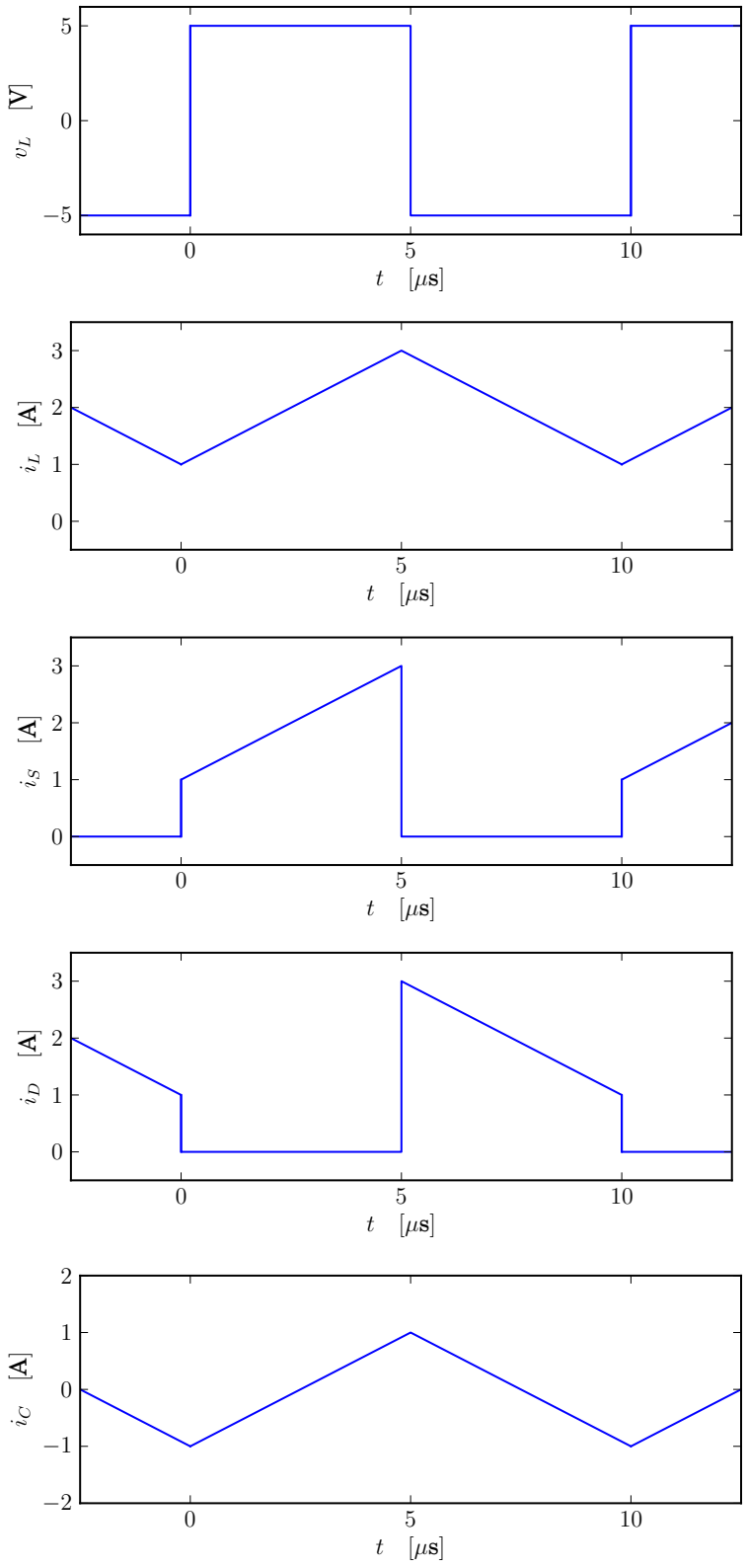
$I_{OUT} > I_{OUTcrit}$, CCM

$$I_1 + I_0 = 2\,I_{OUT} = 4\,\text{A}$$

$$I_1 - I_0 = \frac{V_{IN} - V_{OUT}}{L}\,D\,T_S = 2\,\text{A}$$

$$I_m = I_1 = 3\,\text{A}$$

$$I_0 = 1\,\text{A}$$



Slika 1: Dijagrami, 1.a.

b)

$$I_{OUT} = \frac{5\,\mathrm{V}}{20\,\Omega} = 0.25\,\mathrm{A}$$

$I_{OUT} < I_{OUTcrit}$, DCM

$$I_m = \frac{V_{IN} - V_{OUT}}{L}\, D\, T_S$$

$$I_{OUT} = \overline{i_L} = \frac{I_m^2}{4\,\mathrm{A}}$$

$$I_m = 1\,\mathrm{A}$$

$$D = 0.25$$

c)

$I_{OUT} > 1\,\mathrm{A}$, $R < 5\,\Omega$, CCM

$$I_m = I_{OUT} + 1\,\mathrm{A} = \frac{5\,\mathrm{V}}{R} + 1\,\mathrm{A}$$

$I_{OUT} < 1\,\mathrm{A}$, $R > 5\,\Omega$, DCM

$$I_m = \sqrt{4\,\mathrm{A}\; I_{OUT}} = \sqrt{\frac{20\,\mathrm{W}}{R}}$$

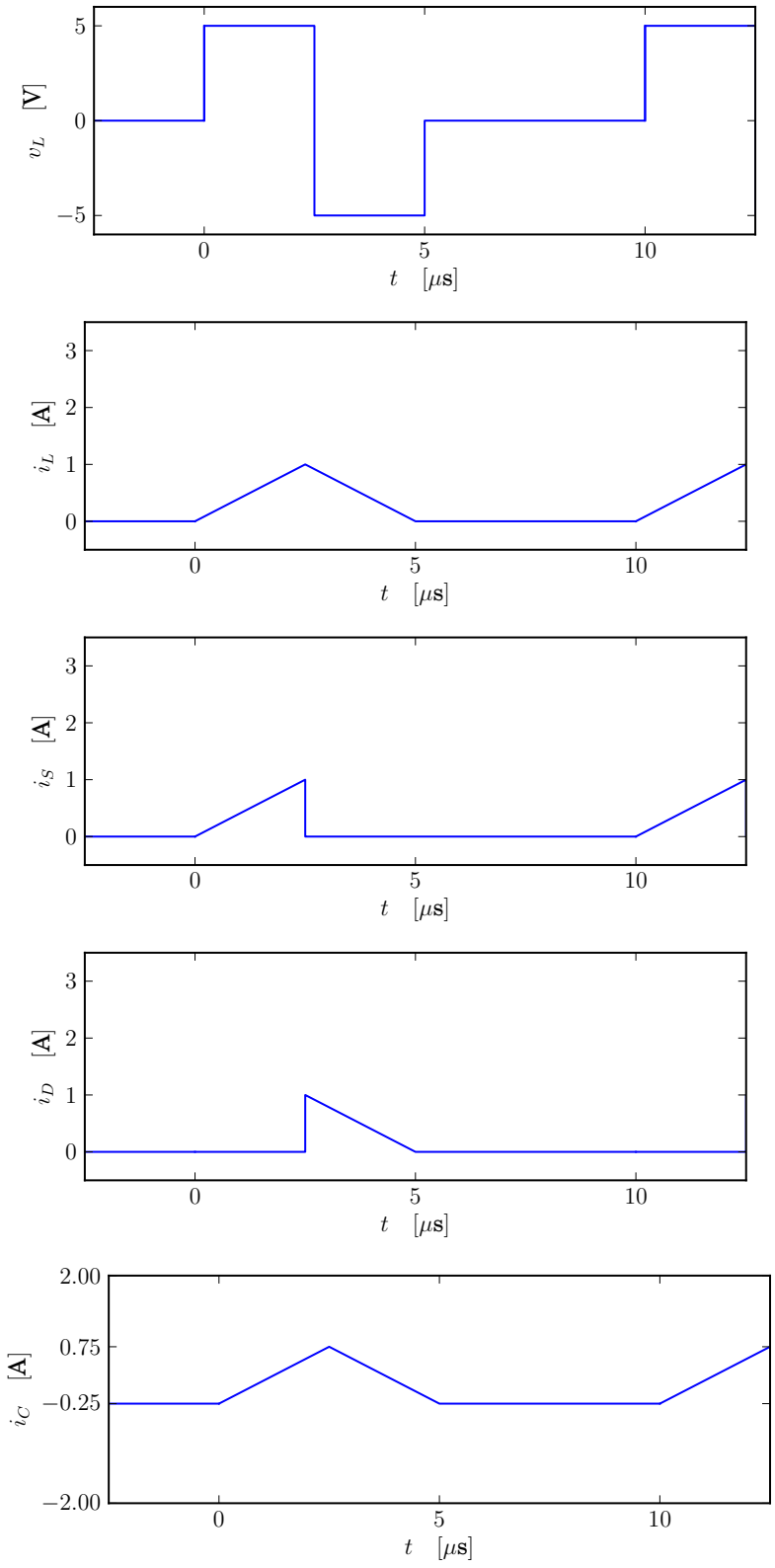
d)

$$\overline{i_L} = I_m - 1\,\mathrm{A}$$

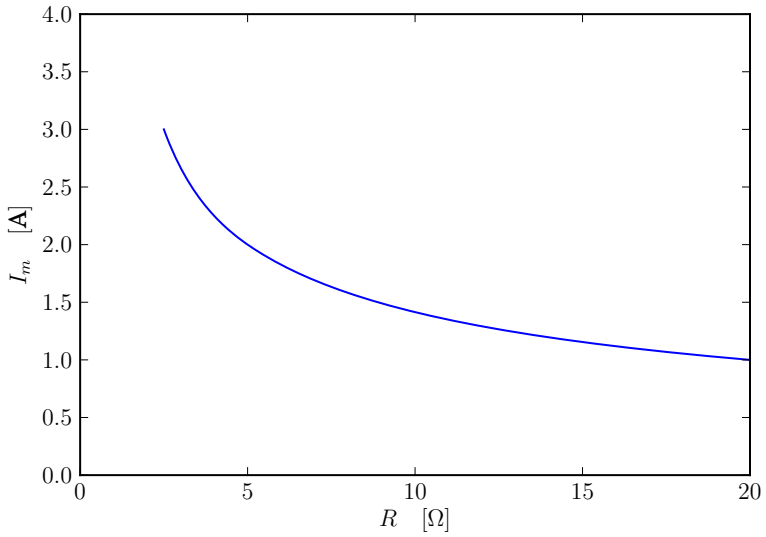
$$\widehat{\overline{i_L}} = \widehat{I}_m$$

$$Z(s) = \frac{\widehat{v}_{OUT}(s)}{\widehat{I}_m(s)} = \frac{\widehat{v}_{OUT}(s)}{\widehat{\overline{i_L}}(s)} = \frac{R}{1 + s\,CR}$$

$$Z(s) = \frac{2.5\,\Omega}{1 + s \times 1\,\mathrm{ms}}$$



Slika 2: Dijagrami, 1.b.



Slika 3: $I_m(R)$