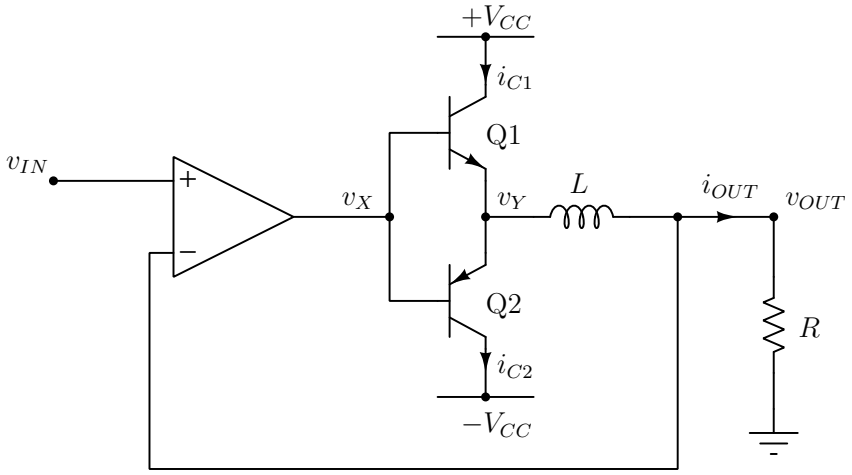
ANALOGNA ELEKTRONIKA, kolokvijum 2014. **20.12.2014.**

1. Na slici 1 je prikazan sistem za programiranje struje kalema primenom pojačavača snage u klasi B koji proširuje strujni kapacitet operacionog pojačavača. Poznato je $V_{CC} = 15\,\mathrm{V}$, $R = 10\,\Omega$, $L = 10\,\mathrm{mH}$, $\omega_0 = 1\,\frac{\mathrm{krad}}{\mathrm{s}}$, $\beta_F \to \infty$, $V_{BE} = 0.75\,\mathrm{V}$, operacioni pojačavač je idealan, $v_{IN} = 1\,\mathrm{V}\,\sin(\omega_0\,t)$.
a) [6] Odrediti vremenske dijagrame napona v_{OUT}, v_Y i v_X, kao i struja i_{OUT}, i_{C1} i i_{C2}.
b) [2] Koristeći zakon o održanju energije odrediti srednju snagu disipacije na tranzistorima Q1 i Q2, $P_D = P_{D1} + P_{D2}$.
c) [2] Odrediti vremenski dijagram trenutne snage disipacije na tranzistoru Q1, $p_{D1}(t)$, i proceniti njenu maksimalnu trenutnu vrednost (greška u proceni od 20% se toleriše).



Slika 1

a) [6]

$v_{OUT} = v_{IN} = 1\,\mathrm{V}\,\sin(\omega_0\,t)$

$i_{OUT} = \dfrac{v_{OUT}}{R} = 100\,\mathrm{mA}\,\sin(\omega_0\,t)$

$$i_{C1} = \begin{cases} i_{OUT}, & i_{OUT} \geq 0 \\ 0, & i_{OUT} < 0 \end{cases}$$

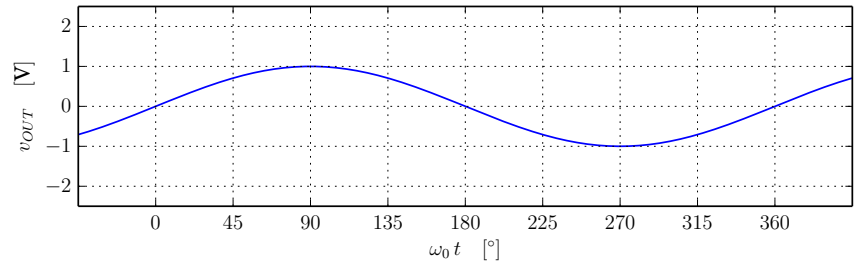
$$i_{C2} = \begin{cases} -i_{OUT}, & i_{OUT} < 0 \\ 0, & i_{OUT} \geq 0 \end{cases}$$

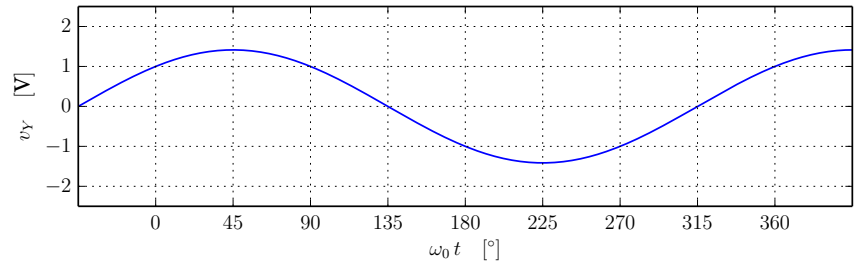
$v_L = L\dfrac{d\,i_L}{dt} = \omega_0\,L\,I_m\,\cos(\omega_0\,t)$, $I_m = 100\,\mathrm{mA}$

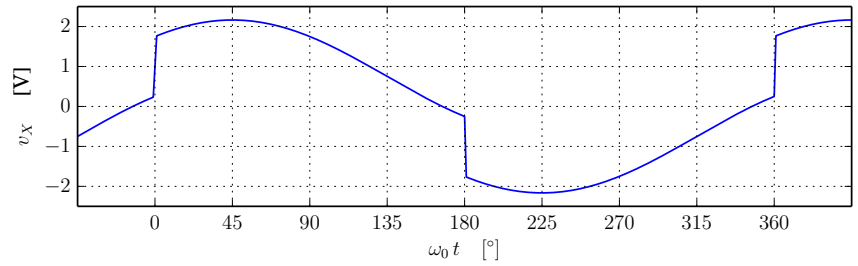
$v_L = L\dfrac{d\,i_L}{dt} = 1\,\mathrm{V}\,\cos(\omega_0\,t)$

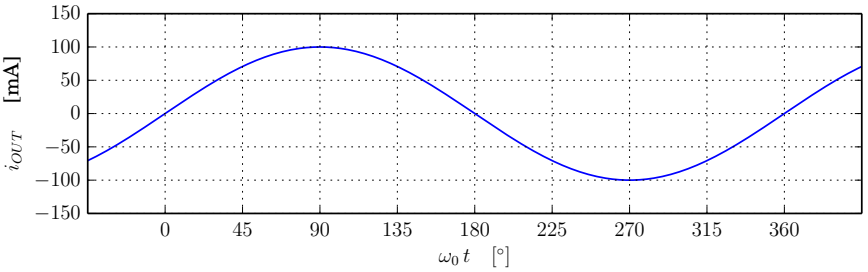
$v_Y = v_{OUT} + v_L = 1\,\mathrm{V}\,(\sin(\omega_0\,t) + \cos(\omega_0\,t)) \approx 1.41\,\mathrm{V}\sin\left(\omega_0\,t + \dfrac{\pi}{4}\right)$

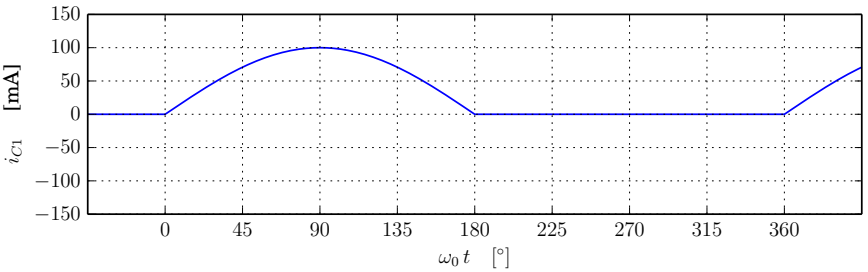
$v_x = v_Y + V_D\,\mathrm{sgn}(i_{OUT}) \approx 1.41\,\mathrm{V}\sin\left(\omega_0\,t + \dfrac{\pi}{4}\right) + 0.75\,\mathrm{V}\,\mathrm{sgn}(\sin(\omega_0\,t))$

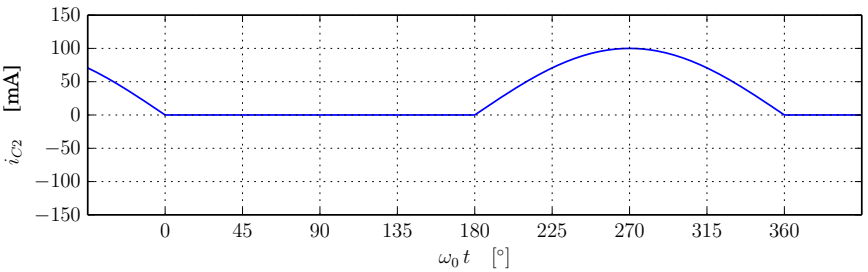

2
1
0
−1
−2
v_{OUT} [V]
0 45 90 135 180 225 270 315 360
$\omega_0 t$ [°]

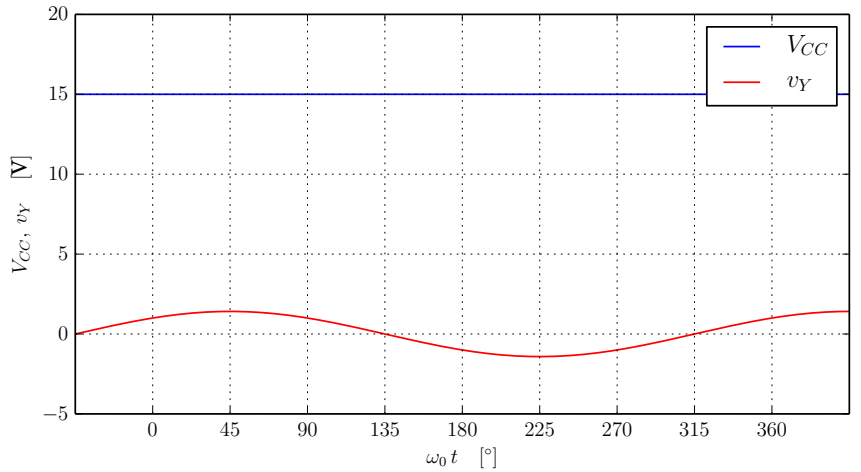

2
1
0
−1
−2
v_Y [V]
0 45 90 135 180 225 270 315 360
$\omega_0 t$ [°]

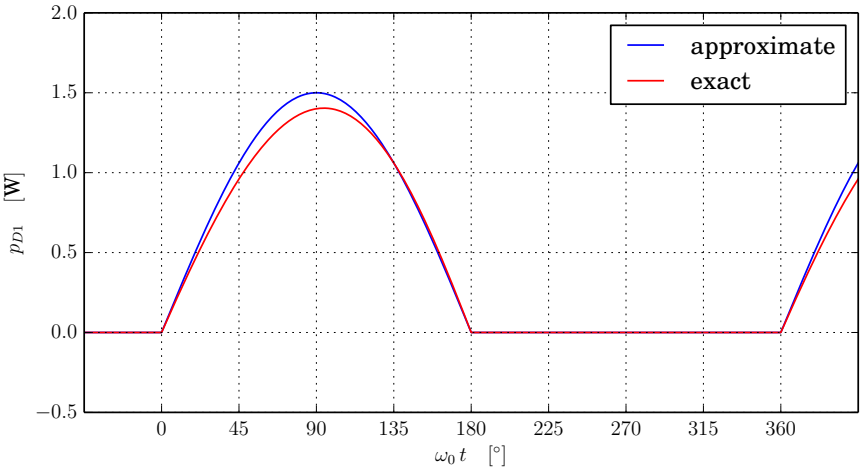

2
1
0
−1
−2
v_X [V]
0 45 90 135 180 225 270 315 360
$\omega_0 t$ [°]


150
100
50
0
−50
−100
−150
i_{OUT} [mA]
0 45 90 135 180 225 270 315 360
$\omega_0 t$ [°]


150
100
50
0
−50
−100
−150
i_{C1} [mA]
0 45 90 135 180 225 270 315 360
$\omega_0 t$ [°]


150
100
50
0
−50
−100
−150
i_{C2} [mA]
0 45 90 135 180 225 270 315 360
$\omega_0 t$ [°]





b) [2]

$$P_{CC} = \frac{2}{\pi} V_{CC} I_m = \frac{2}{\pi} 1.5\,\mathrm{W} \approx 0.9549\,\mathrm{W}$$

$$P_{OUT} = \frac{(V_{OUT\,m})^2}{2\,R} = 50\,\mathrm{mW}$$

$$P_D = P_{CC} - P_{OUT} \approx 0.9049\,\mathrm{W}$$

c) [2]

$p_{D1} = (V_{CC} - v_Y)\; i_{C1} \approx V_{CC}\, i_{C1}$

pošto je v_Y uvek manje od $20\%\, V_{CC} = 3\,\mathrm{V}$, štaviše, manje je i od $10\%\, V_{CC} = 1.5\,\mathrm{V}$

$p_{D1} \approx 1.5\,\mathrm{W}\, \sin(\omega_0 t)$

$p_{D1\,max} \approx 1.5\,\mathrm{W}$

Numerički dobijen rezultat:

$p_{D1\,max} = 1.404\,\mathrm{W}$ za $\omega_0 t = 94°$