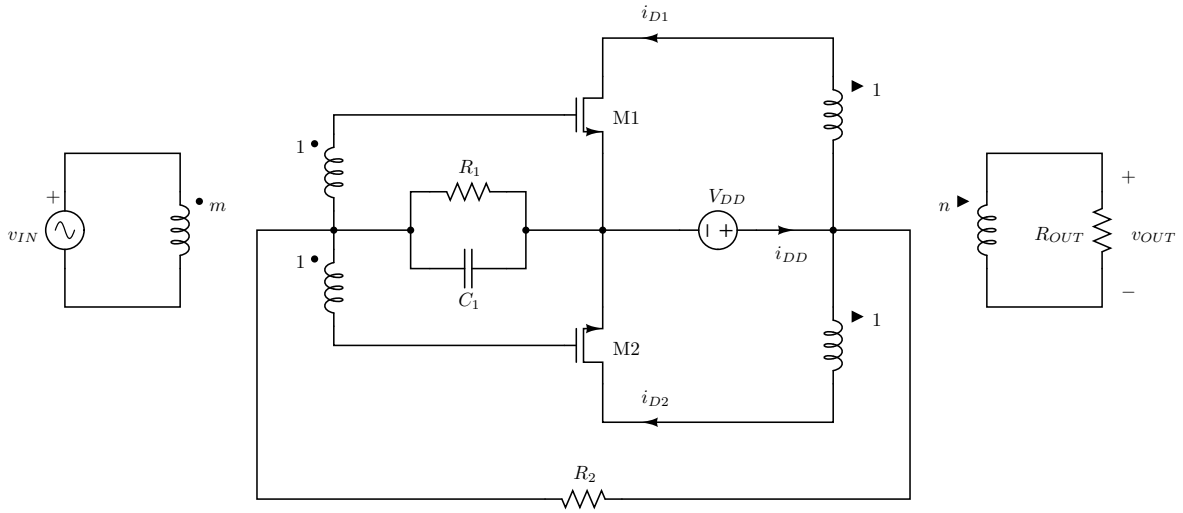
ANALOGNA ELEKTRONIKA, kolokvijum 2011. **10.12.2011.**

1. Na slici 1 je prikazan pojačavač snage u klasi A kod koga je $V_{DD} = 12$ V, $m = 2$, $R_1 = 10$ kΩ, $R_2 = 30$ kΩ, $C_1 \to \infty$, $n = 5$, $R_{OUT} = 625$ Ω, tranzistori su sa $B = 200$ mA/V^2, $V_T = 2$ V.
a) [2] Odrediti disipacije na tranzistorima u mirnoj radnoj tački, P_{D1Q} i P_{D2Q}.
b) [2] Odrediti prenosnu funkciju $v_{OUT}\,(v_{IN})$ pod pretpostavkom da su tranzistori u zasićenju.
Za $v_{IN} = 2$ V $\sin(\omega t)$:
c) [2] Odrediti vremenske dijagrame v_{GS1}, v_{GS2}, v_{DS1}, v_{DS2} i v_{OUT}.
d) [2] Odrediti vremenske dijagrame i_{D1}, i_{D2}, i i_{DD}.
e) [2] Odrediti koeficijent korisnog dejstva η.



Slika 1.

REŠENJE:

a) [2]

$$V_{GS1Q} = V_{GS2Q} = V_{GSQ} = \frac{R_1}{R_1 + R_2}\,V_{DD} = \frac{10\text{ k}\Omega}{10\text{ k}\Omega + 30\text{ k}\Omega}\,12\text{ V} = 3\text{ V}$$

$$I_{D1Q} = I_{D2Q} = \frac{B}{2}\,(V_{GSQ} - V_T)^2 = 100\,\frac{\text{mA}}{\text{V}^2}\,(3\text{ V} - 2\text{ V})^2 = 100\text{ mA}$$

$$\boxed{P_{D1Q} = P_{D2Q} = V_{DD}\,I_{DQ} = 1.2\text{ W}}$$

b) [2]

$$v_{GS1} = V_{GSQ} + \frac{v_{IN}}{m}$$

$$v_{GS2} = V_{GSQ} - \frac{v_{IN}}{m}$$

$$i_{D1} = \frac{B}{2}\,(v_{GS1} - V_T)^2 = \frac{B}{2}\left(V_{GSQ} - V_T + \frac{v_{IN}}{m}\right)^2$$

$$i_{D2} = \frac{B}{2}\left(v_{GS2} - V_T\right)^2 = \frac{B}{2}\left(V_{GSQ} - V_T - \frac{v_{IN}}{m}\right)^2$$

$$n\, i_{OUT} = n\,\frac{v_{OUT}}{R_{OUT}} = i_{D2} - i_{D1}$$

$$v_{OUT} = \frac{R_{OUT}}{n}\left(i_{D2} - i_{D1}\right)$$

$$\boxed{v_{OUT} = -\frac{2BR_{OUT}}{nm}\left(V_{GSQ} - V_T\right) v_{IN} = -25\, v_{IN}}$$

c) [2] (slike na kraju)

$$\boxed{v_{GS1} = V_{GSQ} + \frac{v_{IN}}{m} = 3\ \text{V} + 1\ \text{V}\ \sin(\omega t)}$$

$$\boxed{v_{GS2} = V_{GSQ} - \frac{v_{IN}}{m} = 3\ \text{V} - 1\ \text{V}\ \sin(\omega t)}$$

$$\boxed{v_{OUT} = -25\, v_{IN} = -50\ \text{V}\ \sin(\omega t)}$$

$$\boxed{v_{DS1} = V_{DD} + \frac{v_{OUT}}{n} = 12\ \text{V}\ - 10\ \text{V}\ \sin(\omega t)}$$

$$\boxed{v_{DS2} = V_{DD} - \frac{v_{OUT}}{n} = 12\ \text{V}\ + 10\ \text{V}\ \sin(\omega t)}$$

d) [2] (slike na kraju)

$$\boxed{i_{D1} = \frac{B}{2}\left(V_{GSQ} - V_T + \frac{v_{IN}}{m}\right)^2 = 100\ \text{mA}\ \ (1 + \sin(\omega t))^2}$$

$$\boxed{i_{D2} = \frac{B}{2}\left(V_{GSQ} - V_T - \frac{v_{IN}}{m}\right)^2 = 100\ \text{mA}\ \ (1 - \sin(\omega t))^2}$$

$$\boxed{i_{DD} = i_{D1} + i_{D2} = 200\ \text{mA}\ \left(1 + \sin^2(\omega t)\right) = 300\ \text{mA} - 100\ \text{mA}\ \cos(2\omega t)}$$

gornji rezultat je dobijen uz zanemarivanje struje razdelnika $\frac{V_{DD}}{R_1+R_2} = 0.3$ mA

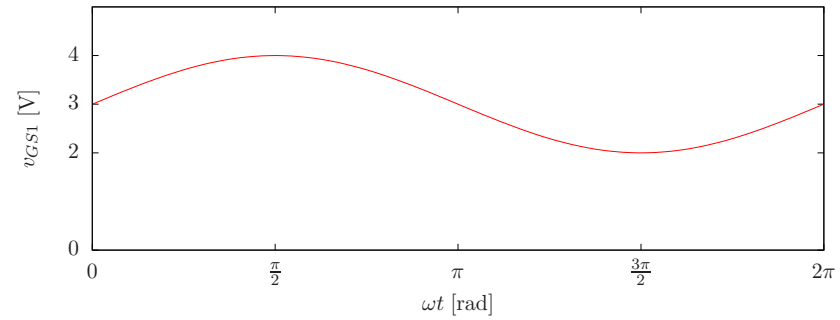
e) [2]

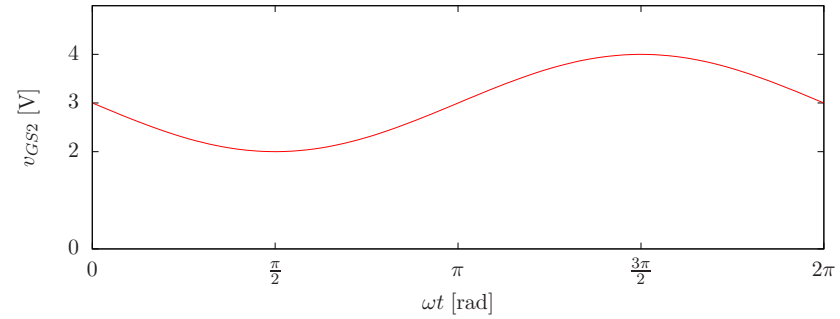
$$\eta = \frac{P_{OUT}}{P_{DD}}$$

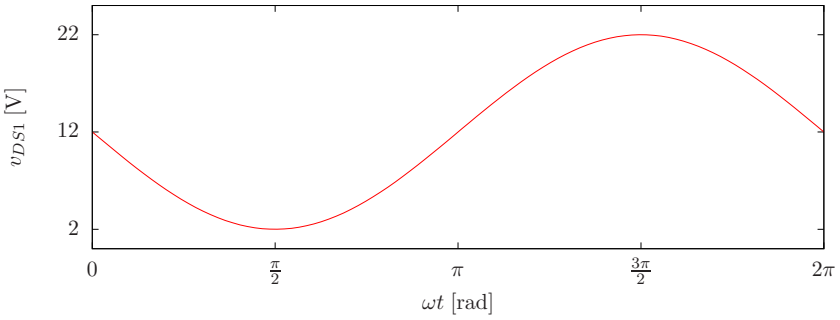
$$P_{OUT} = \frac{V_{OUTm}^2}{2R_{OUT}} = \frac{(50\ \text{V})^2}{2 \times 625\ \Omega} = 2\ \text{W}$$

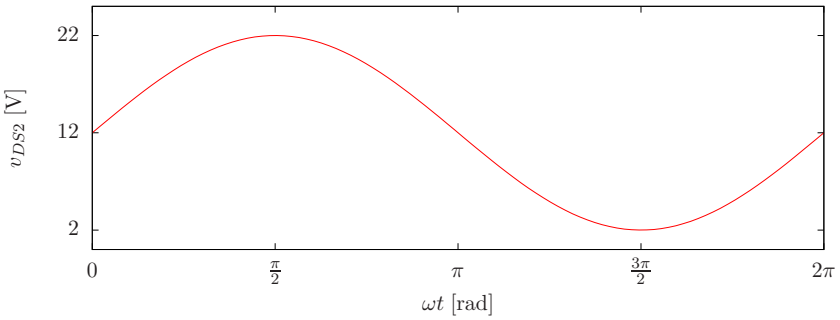
$$P_{DD} = V_{DD}\,\overline{i_{DD}} = 12\ \text{V} \times 300\ \text{mA} = 3.6\ \text{W}$$

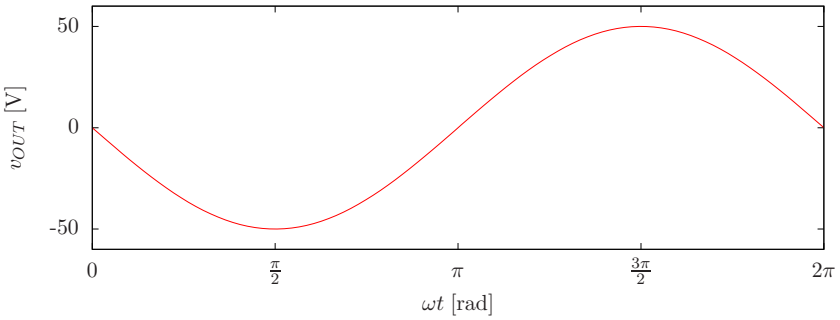
$$\boxed{\eta = \frac{2\ \text{W}}{3.6\ \text{W}} = \frac{5}{9} = 55.56\%}$$

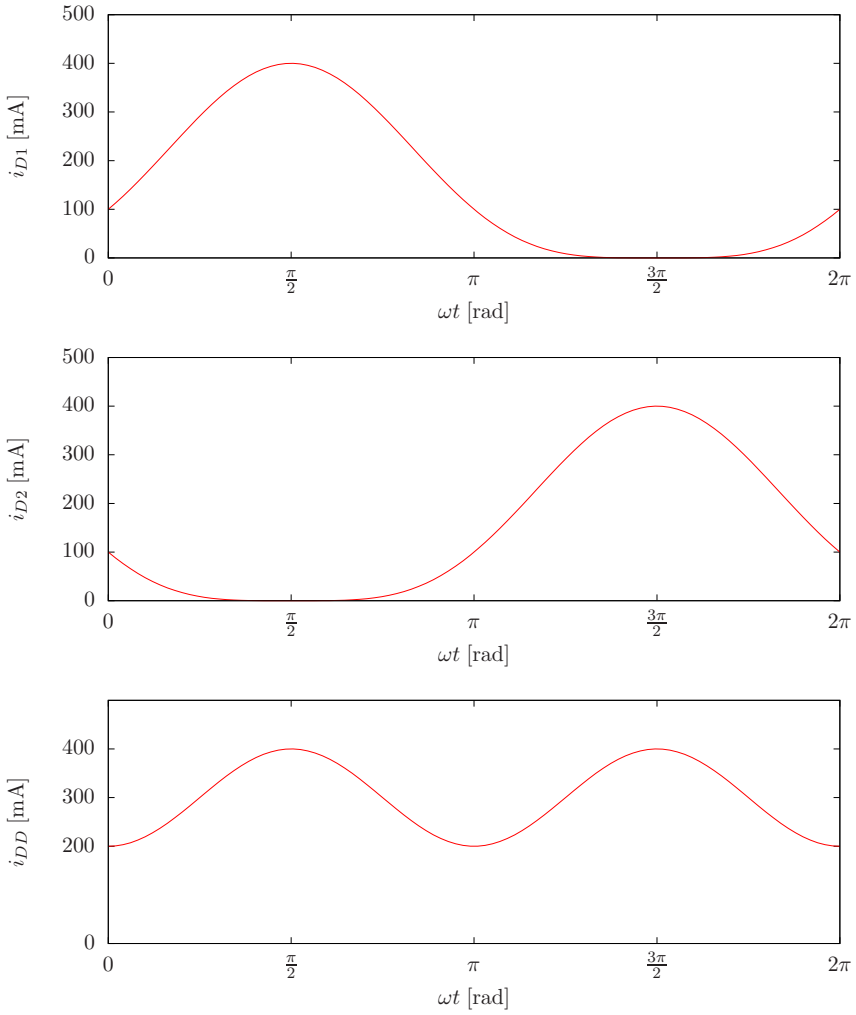

4
3
2
0
v_{GS1} [V]
0
$\frac{\pi}{2}$
π
$\frac{3\pi}{2}$
2π
ωt [rad]


4
3
2
0
v_{GS2} [V]
0
$\frac{\pi}{2}$
π
$\frac{3\pi}{2}$
2π
ωt [rad]


22
12
2
v_{DS1} [V]
0
$\frac{\pi}{2}$
π
$\frac{3\pi}{2}$
2π
ωt [rad]


22
12
2
v_{DS2} [V]
0
$\frac{\pi}{2}$
π
$\frac{3\pi}{2}$
2π
ωt [rad]


50
0
-50
v_{OUT} [V]
0
$\frac{\pi}{2}$
π
$\frac{3\pi}{2}$
2π
ωt [rad]


500
400
300
200
100
0
i_{D1} [mA]
0
$\frac{\pi}{2}$
π
$\frac{3\pi}{2}$
2π
ωt [rad]
500
400
300
200
100
0
i_{D2} [mA]
0
$\frac{\pi}{2}$
π
$\frac{3\pi}{2}$
2π
ωt [rad]
400
300
200
0
i_{DD} [mA]
0
$\frac{\pi}{2}$
π
$\frac{3\pi}{2}$
2π
ωt [rad]