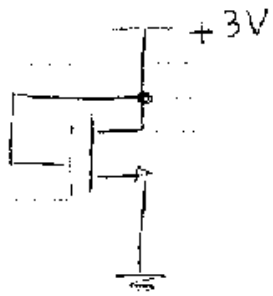
ES. A

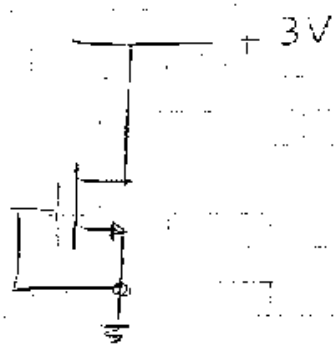
a)



$V_{GS} = +3V > V_T$ } MOS acceso
$V_{GD} = 0V < V_T$ } MOS Saturo

$I_D = k_n (V_{GS} - V_T)^2 = 1 mA/V^2 \cdot (3V - 1V)^2 = 4 mA$

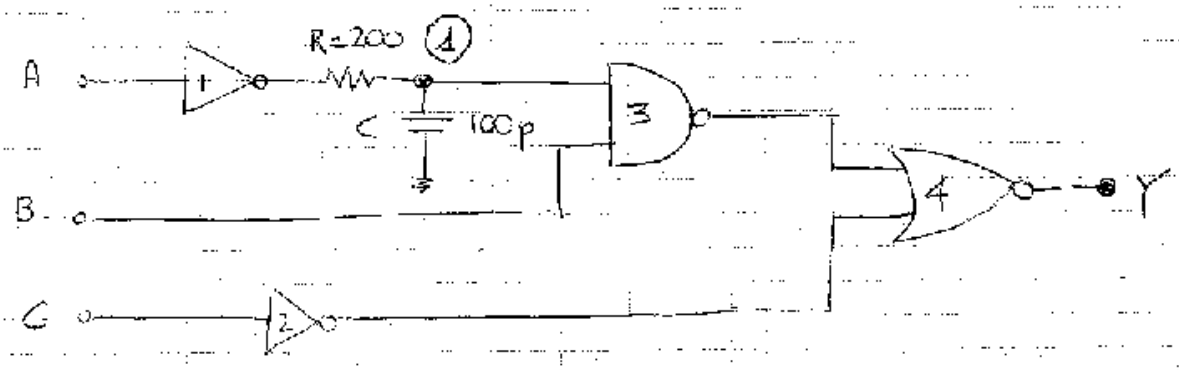
b)



$V_{GD} = -3V < V_T$ } MOS spenta
$V_{GS} = 0V$ } non c'è canale

$I_D = 0$

ES. C

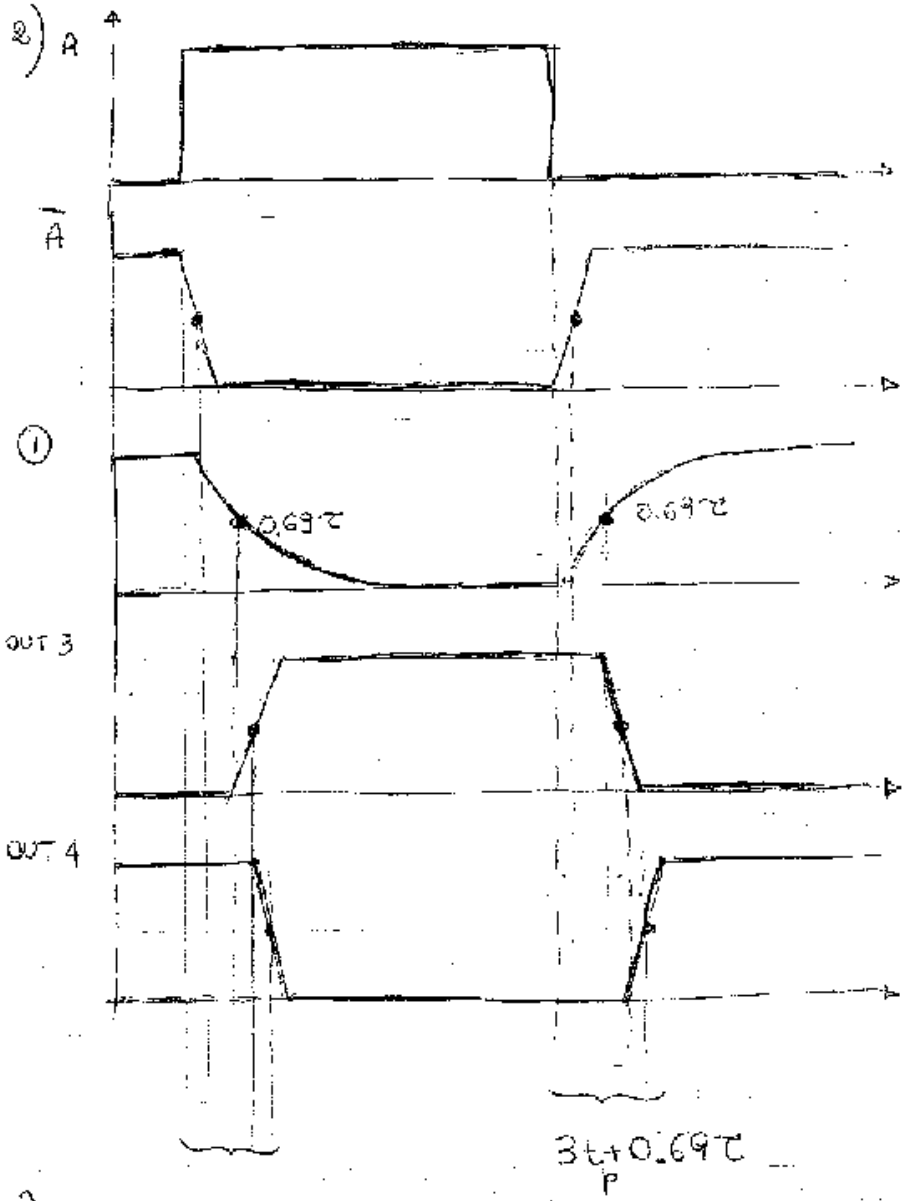


1)

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
1	0	0	0
0	1	1	1
1	0	1	0

A	B	C	Y
1	1	0	0
1	1	1	0

2)



$\tau = R * C =$

$= 200 * 100\,10^{-12} =$

$= 20\ ns$

$t_p = 20\ ns$

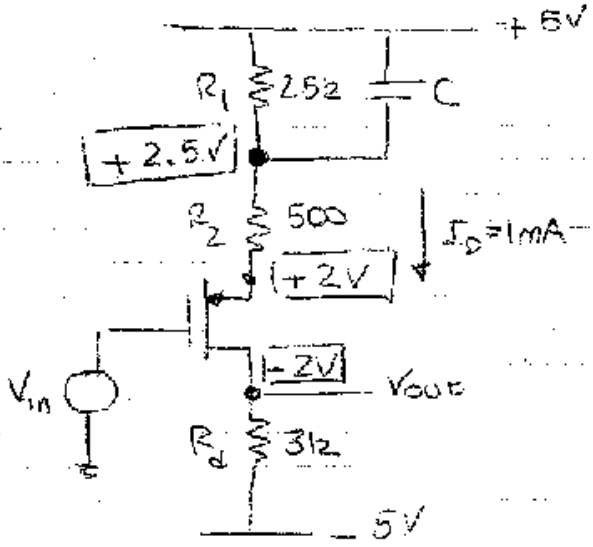
3) $3t_p + 0.69\tau =$

$$\Downarrow$$

$$f_{MAX} = \left[2 * \left(3t_p + 0.69\tau\right)\right]^{-1} = \left[2 * \left(3 * 20ns + 0.69 * 20ns\right)\right]^{-1} =$$

$$= \left[2 * (60ns + 13.8\ ns)\right]^{-1} = \frac{1}{147.6\ ns} = 6.78\ MHz$$

ES 0



1) $V_{SG} > 0$

$$\begin{cases} 5V = 312 \times I_D + V_{SG} \\ I_D = k_2 (V_{SG} - |V_T|)^2 \end{cases}$$

$$5 = 312 \times 1mA/V^2 (V_{SG} - |V_T|)^2 + V_{SG}$$

$$5 = 3 V_{SG}^2 - 6 V_{SG} + 3 + V_{SG}$$

$$3 V_{SG}^2 - 5 V_{SG} - 2 = 0$$

$$V_{SG} = \frac{5 \pm \sqrt{25+24}}{6} = \frac{5 \pm 7}{6} \begin{cases} 2V \text{ OK} \\ -2/6 V \text{ NO} \end{cases}$$

$$I_D = 1mA/V^2 (2V - 1V)^2 = 1mA$$

$V_{GD} = 2V > V_T$ OK

$$g_m = 2k_2 |(V_{GS} - V_T)| = 2mA/V \Rightarrow 1/g_m = 500\Omega$$

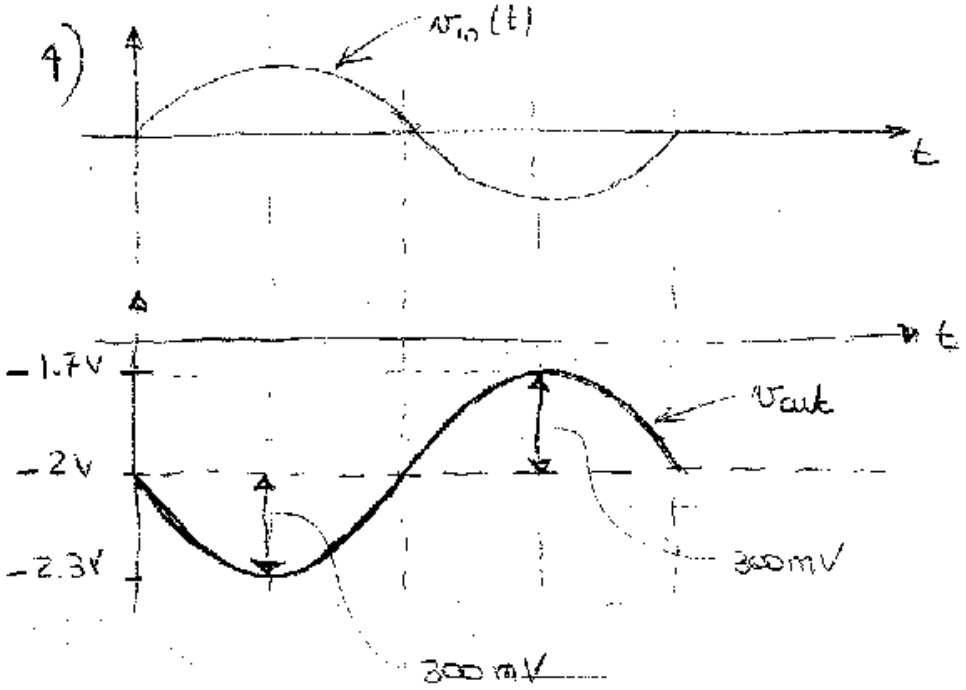
2) $$\left|\frac{v_{out}}{v_{in}}\right|_{LF} = \frac{1/g_m}{1/g_m + R_1 + R_2} (-g_m R_D) = -\frac{g_m R_D}{1 + g_m (R_1 + R_2)} = -\frac{6}{1+2+3} =$$

$$= -6/7 = -0.86$$

3) $$\left|\frac{v_{out}}{v_{in}}\right|_{HF} = \frac{1/g_m}{1/g_m + R_2} \cdot (-g_m R_D) = -\frac{g_m R_D}{1 + g_m R_2} = -\frac{6}{1+2\cdot 0.5}$$

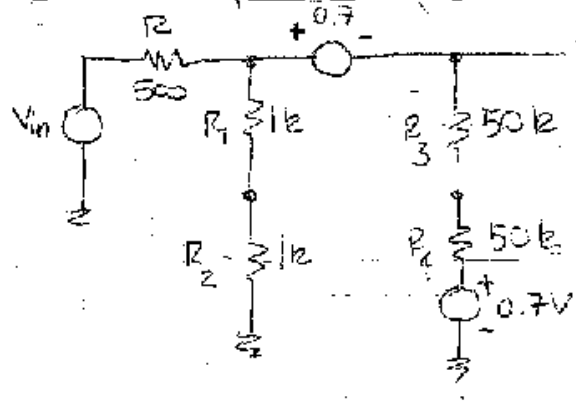
$$= -\frac{6}{2} = -3$$

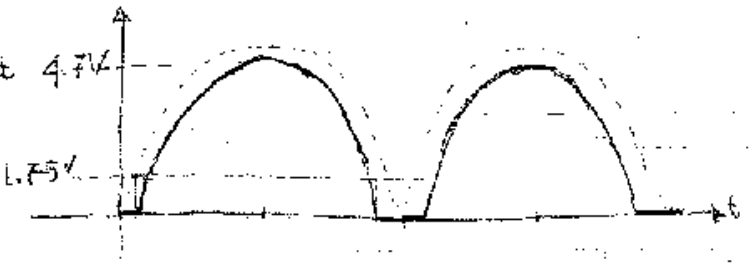
4)



ES. B

Semionda positiva (D_1 e D_3 on)





D_1 e D_3 si accendono quando:

$$V_{in} + \frac{2k}{2.5k} = 1.4V \Leftrightarrow V_{in} = 1.4 \cdot \frac{2.5}{2} = 1.75V$$

a) picco:

$$V_{out} = 5V * \frac{(R_3+R_4) \,//\, (R_1+R_2)}{R + (R_3+R_4) \,//\, (R_1+R_2)} + 0.7V \frac{(R_3+R_4)}{R \,//\, (R_1+R_2) + (R_3+R_4)} +$$

$$+ \frac{R \,//\, (R_1+R_2)}{(R_3+R_4) \,//\, R + (R_3+R_4)} 0.7V = 5V \frac{2k}{2.5k} + 0.7V \frac{100k}{100k + \underbrace{2k \,//\, 500}_{400}} +$$

$$+ 0.7V \frac{2k \,//\, 500}{100k + 2k \,//\, 500} = 5V \frac{2k}{2.5k} + 0.7V = 4.7V$$