① ERRORE DI INTERCONNESSIONE

$R_{s1} = R_{s2} = 5\,K\Omega$ $\quad \Delta = \left|\frac{y_0 - y}{y_0}\right|$

$R_{d1} = R_{d2} = 50\,K\Omega$

$R_i = 1\,M\Omega$

$\Rightarrow \frac{y_0 - y}{y_0} = \frac{R^{sx}_{EQ.}}{R^{sx}_{EQ.} + R_i} = \frac{110K}{110K + 1M} = \underline{0{,}099}$

② TERMORESTENZA

$R_1 = 150\,\Omega$ $\quad T_0 = 25\,°C$ $\quad V_0 = ?$

$R_3 = 300\,\Omega$ $\quad T_1 = 9\,V$

$R_4 = 600\,\Omega$ $\quad \alpha = 4\,\%\,C^{-1}$

$V_{in} = 9\,V$

$\Rightarrow R_1 \cdot R_4 = R_2 \cdot R_3 \Rightarrow R_2 = \frac{R_1 \cdot R_4}{R_3} = 300\,\Omega$

$A = \frac{R_1}{R_2} = 0{,}5$; $\frac{\Delta R_1}{R_1} = \alpha \Delta T = 0{,}056$

$\underline{V_0} = \frac{A}{(1+A)^2} \frac{\Delta R_1}{R_1} V_{in} = \underline{0{,}112\,V}$

③ ESTENSIMETRO

$R_1 = 100\,\Omega$ $\quad l = 0{,}02\,m$ $\quad V_0 = ?$

$R_3 = 100\,\Omega$ $\quad \Delta l = 0{,}001\,m$

$R_4 = 400\,\Omega$ $\quad G = 2$

$V_{in} = 20\,V$

$\Rightarrow R_1 R_4 = R_2 R_3 \Rightarrow R_2 = \frac{R_1 \cdot R_4}{R_3} = 400\,\Omega$

$A = \frac{R_1}{R_2} = 0{,}25$; $\frac{\Delta R_1}{R_1} = G \cdot \frac{\Delta l}{l} = 0{,}1$

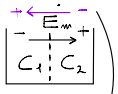
$\underline{V_0} = \frac{A}{(1+A)^2} \frac{\Delta R_1}{R_1} V_{in} = \underline{0{,}32\,V}$

④ POTENZIALE DI MEMBRANA a

ione K^+ $\quad a_i = c_i$ $\quad E_m = ?$

$C_1 = 5{,}5\,mM$; $C_2 = 150\,mM$

$T = 37\,°C = 310\,K$



$\Rightarrow \underline{E_m} = \frac{RT}{zF} \ln\left(\frac{c_1}{c_2}\right) = \underline{-88{,}2\,mV}$

$\underline{E_m} = \underline{+88{,}2\,mV}$

⑤ POTENZIALE DI MEMBRANA b

ione Cl^- $\quad E_m = ?$

$C_1 = 125\,mM$, $C_2 = 9\,mM$

$T = 37\,°C = 310\,K$

$\Rightarrow \underline{E_m} = \frac{RT}{zF} \ln\left(\frac{c_1}{c_2}\right) = \underline{-70{,}2\,mV}$

⑥ POTENZIALE DI MEMBRANA c

ione Ca^{2+} $\quad E_m = ?$

$C_1 = 150\,mM$, $C_2 = 5{,}5\,mM$

$T = 37\,°C = 310\,K$

$\Rightarrow \underline{E_m} = \frac{RT}{zF} \ln\left(\frac{c_1}{c_2}\right) = \underline{44{,}1\,mV}$

⑦ TRIANGOLO DI EINTHOVEN a

$K|H| = 1\,mV$ $\quad aV_R = ?$

$\vartheta = -150°$

$\Rightarrow V_I = KH \cos\vartheta = -\sqrt{3}/2$

$V_{II} = \frac{KH}{2}(\cos\vartheta - \sqrt{3}\sin\vartheta) = 0$

$\underline{aV_R} = -\frac{1}{2}(V_I + V_{II}) = \underline{0{,}433\,mV}$

⑧ TRIANGOLO DI EINTHOVEN b

$V_I = 0{,}5\,mV$ $\quad \vartheta = ?$

$V_{II} = 1\,mV$

$\Rightarrow \underline{\vartheta} = \arctg\left(\frac{2}{\sqrt{3}}\left(\frac{1}{2} - \frac{V_{II}}{V_I}\right)\right) = \underline{-60°}$

⑨ ULTRASUONI a

$D = 0{,}012\,m$ $\quad f = ?$

$Z_m = 0{,}006\,mm$; $c = 1540\,m/s$

$\Rightarrow \lambda = \frac{D^2}{4 Z_m} = 6 \cdot 10^{-4}\,m$

$\underline{f} = \frac{c}{\lambda} = \underline{2{,}567\,MHz}$

⑩ ULTRASUONI b

$q = Z_m/F = 2$; $c = 1540\,m/s$ $\quad W = ?$

$F = 0{,}1\,m$; $f = 3{,}5\,MHz$

$\Rightarrow Z_m = q \cdot F = 0{,}2\,m$; $\lambda = \frac{c}{f} = 4{,}4 \cdot 10^{-4}\,m$

$D = \sqrt{4 \lambda Z_m} = 0{,}01876\,m$;

$\underline{W} = \frac{\lambda \cdot F}{D} = \underline{2{,}345\,mm}$

⑪ ULTRASUONI c

$F_R = 7000\,Hz$ $\quad Z_p = ?$

$\Rightarrow \underline{Z_p} = \frac{c}{2 \cdot F_R} = \underline{110\,mm}$

⑫ ULTRASUONI d

$Z_p = 0{,}15\,m$ $\quad f_{max} = ?$

$\Rightarrow \underline{f_{max}} \leq \frac{c}{2 \cdot Z_p} = \underline{5133{,}33\,Hz}$

⑬ ULTRASUONI e

$D = 0{,}007\,m$ $\quad Z_m = ?$

$f = 10\,MHz$

$\Rightarrow \lambda = \frac{c}{f} = 1{,}54 \cdot 10^{-6}\,m$

$\underline{Z_m} = \frac{D^2}{4 \cdot \lambda} = \underline{8\,cm}$

⑭ ULTRASUONI f

$d = 0{,}025\,m$ (DIST. ECHI) $\quad t = ?$

$\Rightarrow \underline{t} = \frac{2d}{c} = \underline{32{,}5\,\mu s}$

⑮ ULTRASUONI g

$M = 128$ LINEE $\quad T_{frame} = ?$

$Z_{max} = 0{,}2\,m$

$\Rightarrow \underline{T_{frame}} = M \cdot T_{PR} = M \cdot \frac{2 Z_{max}}{c} = \underline{33{,}247\,ms}$

⑯ MRI

$B_0 = 3\,T$ $\quad |M_0| = 1$

$\alpha = \pi/4$ $\quad M_{xy}(t) = ?$

$T_2 = 50\,ms$ $\quad t = 50\,ms$

$\Rightarrow \underline{M_{xy}(t)} = |M_{xy}| \sin\alpha \cdot e^{-t/T_2} = \underline{0{,}26}$

17 MRI

$|M_z| = 0 \qquad |M_{x,y}| = 1 \qquad \alpha = ?$

$\vartheta = \pi/2 \qquad t = 80\ ms$

$T_1 = 240\ ms \quad T_2 = 45\ ms$

$\Rightarrow M_{xy}(t) = |M_{xy}| \sin\vartheta \cdot e^{-t/T_2} = 0{,}169$

$M_z(t) = |M_{xy}|(1 - e^{-t/T_1}) + |M_z| e^{-t/T_1} = 0{,}283$

$\underline{\alpha} = \operatorname{arctg}\left(\frac{M_{xy}(t)}{M_z(t)}\right) = \underline{31°}$

18 MEDICINA NUCLEARE

$V = 800\ ml \quad t_{dim} = 20\ min, \quad N_0 = ?$ DOSE MINIMA

$A = 0{,}5\ KBeq/ml \quad t = 120\ min$

$\Rightarrow \lambda = \frac{\ln 2}{t_{dim}} = 5{,}776 \cdot 10^{-4} \quad A(t) = A \cdot V = 400\ KBeq$

$N(t) = \frac{A(t)}{\lambda} = \frac{400K}{5{,}776 \cdot 10^{-4}} = 693\ M$

$\underline{N_0} = N(t) e^{\lambda t} = \underline{44{,}3\ G}$

19 MEDICINA NUCLEARE

Protone H $\quad B_1 = 0{,}6 \cdot 10^{-4}\ G \qquad \Delta t = ?$

$\alpha = \pi/2 \quad \gamma = 42{,}58 \cdot 10^6 \cdot 2\pi$

$\Rightarrow \underline{\Delta t} = \frac{\alpha}{\gamma \cdot B_1} = 9{,}78 \cdot 10^{-5} \cong \underline{0{,}1\ ms}$

20 MEDICINA NUCLEARE

$t_{dim} = 20\ min \qquad \frac{A(t=20\,min)}{A(t=45\,min)} = ?$

dose: $A = \lambda N_0 = 257\ MBeq$

$t = 45\ min\ ;\ A(t = 45\ min) = 20\ KBeq/ml$

$V = 1\ l$

$\Rightarrow A(t = 45\ min) = 20 \cdot 1000 = 20 \cdot 10^3\ KBeq$

$\lambda = \frac{\ln(2)}{t_{dim}} = 5{,}776 \cdot 10^{-4}\ s^{-1}$

$A(t = 20\ min) = \lambda N_0 e^{-\lambda t_{dim}} = 128{,}5 \cdot 10^3\ KBeq$

$\underline{\frac{A(t=20\,min)}{A(t=45\,min)}} = 0{,}1556 \sim \underline{15\ \%}$