

① ERRORE DI INTERCONNESSIONE

$$R_{S1} = R_{S2} = 5 \text{ k}\Omega \quad \Delta = \left| \frac{Y_o - Y}{Y_o} \right|$$

$$R_{D1} = R_{D2} = 50 \text{ k}\Omega$$

$$R_x = 1 \text{ M}\Omega$$

$$\Rightarrow \frac{Y_o - Y}{Y_o} = \frac{R_{EQ}^{sx}}{R_{EQ}^{sx} + R_x} = \frac{110 \text{ k}}{110 \text{ k} + 1 \text{ M}} = 0,039$$

③ ESTENSIMETRO

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

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

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

$$V_{in} = 20 \text{ V}$$

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

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

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

⑤ POTENZIALE DI MEMBRANA b

$$iome Cl^- \quad E_m = ?$$

$$C_1 = 125 \text{ mM}; \quad C_2 = 9 \text{ mM} \quad \boxed{-\frac{E_m}{+} \begin{matrix} + \\ | \\ C_1 : C_2 \end{matrix} +}$$

$$T = 37^\circ \text{C} = 310 \text{ K}$$

$$\Rightarrow E_m = \frac{RT}{zF} \ln \left(\frac{C_1}{C_2} \right) = -70,2 \text{ mV}$$

⑦ TRIANGOLO DI EINTHOVEN a

$$KIH = 1 \text{ mV} \quad a V_R = ?$$

$$\vartheta = -150^\circ$$

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

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

$$a V_R = \frac{2}{2} \left(V_I + V_{II} \right) = 0,433 \text{ mV}$$

⑨ ULTRASUONI a

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

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

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

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

⑩ ULTRASUONI c

$$F_R = 7000 \text{ Hz} \quad Z_p = ?$$

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

⑪ ULTRASUONI e

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

$$f = 10 \text{ MHz}$$

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

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

⑫ ULTRASUONI g

$$M = 128 \text{ LINEE}$$

$$T_{frame} = ?$$

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

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

② TERMORESTENZA

$$R_1 = 150 \Omega \quad T_o = 25^\circ \text{C} \quad V_o = ?$$

$$R_3 = 300 \Omega \quad T_d = 9 \text{ V}$$

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

$$V_{in} = 9 \text{ V}$$

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

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

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

④ POTENZIALE DI MEMBRANA a

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

$$C_1 = 5,5 \text{ mM}; \quad C_2 = 150 \text{ mM} \quad \boxed{-\frac{E_m}{+} \begin{matrix} + \\ | \\ C_1 : C_2 \end{matrix} +}$$

$$T = 37^\circ \text{C} = 310 \text{ K}$$

$$\Rightarrow E_m = \frac{RT}{zF} \ln \left(\frac{C_1}{C_2} \right) = -88,2 \text{ mV}$$

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

⑥ POTENZIALE DI MEMBRANA c

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

$$C_1 = 150 \text{ mM}; \quad C_2 = 5,5 \text{ mM} \quad \boxed{-\frac{E_m}{+} \begin{matrix} + \\ | \\ C_1 : C_2 \end{matrix} +}$$

$$T = 37^\circ \text{C} = 310 \text{ K}$$

$$\Rightarrow E_m = \frac{RT}{zF} \ln \left(\frac{C_1}{C_2} \right) = 44,1 \text{ mV}$$

⑧ TRIANGOLO DI EINTHOVEN b

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

$$V_{II} = 1 \text{ mV}$$

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

⑩ ULTRASUONI b

$$q = z_m/f = 2; \quad c = 1540 \text{ m/s} \quad W = ?$$

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

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

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

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

⑫ ULTRASUONI d

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

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

⑭ ULTRASUONI f

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

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

⑯ MRI

$$B_0 = 3 \text{ T} \quad |M_0| = 1$$

$$\alpha = \pi/4$$

$$M_{xy}(t) = ?$$

$$T_2 = 50 \text{ ms} \quad t = 50 \text{ ms}$$

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

17) MRI

$$\begin{aligned} |M_z| &= 0 & |M_{x,y}| &= 1 & \alpha &=? \\ \vartheta &= \pi/2 & t &= 80 \text{ ms} \\ T_1 &= 240 \text{ ms} & T_2 &= 45 \text{ ms} \\ \Rightarrow M_{xy}(t) &= |M_{xy}| \sin \vartheta \cdot e^{-\frac{t}{T_2}} = 0,169 \\ M_z(t) &= |M_z| (1 - e^{-\frac{t}{T_1}}) + |M_{xy}| e^{-\frac{t}{T_2}} = 0,283 \\ \alpha &= \arctan \left(\frac{M_{xy}(t)}{M_z(t)} \right) = 31^\circ \end{aligned}$$

18) MEDICINA NUCLEARE

$$\begin{aligned} \text{Protone H} \quad B_1 &= 0,6 \cdot 10^{-4} \text{ G} & \Delta t &=? \\ \alpha &= \pi/2 \quad f = 42,58 \cdot 10^6 \cdot 2\pi \\ \Rightarrow \Delta t &= \frac{\alpha}{f \cdot B_1} = 9,78 \cdot 10^{-5} \approx 0,1 \text{ ms} \end{aligned}$$

18) MEDICINA NUCLEARE

$$\begin{aligned} V &= 800 \text{ ml} \quad t_{\text{dim}} = 20 \text{ min}, \quad N_0 = ? \text{ DOSE MINIMA} \\ A &= 0,5 \text{ kBq/ml} \quad t = 120 \text{ min} \\ \Rightarrow \lambda &= \frac{\ln 2}{t_{\text{dim}}} = 5,776 \cdot 10^{-4} \quad A(t) = A \cdot V = 400 \text{ kBq} \\ N(t) &= \frac{A(t)}{\lambda} = \frac{400 \text{ kBq}}{5,776 \cdot 10^{-4}} = 693 \text{ M} \\ N_e &= N(t) e^{\lambda t} = 44,3 \text{ G} \end{aligned}$$

20) MEDICINA NUCLEARE

$$\begin{aligned} t_{\text{dim}} &= 20 \text{ min} & \frac{A(t=20 \text{ min})}{A(t=45 \text{ min})} &=? \\ \text{dose: } A &= \lambda N_0 = 25 \text{ kBq} \\ t &= 45 \text{ min}; \quad A(t=45 \text{ min}) = 20 \text{ kBq/ml} \\ V &= 1 \text{ l} \\ \Rightarrow A(t=45 \text{ min}) &= 20 \cdot 1000 = 20 \cdot 10^3 \text{ kBq} \\ \lambda &= \frac{\ln(2)}{t_{\text{dim}}} = 5,776 \cdot 10^{-4} \text{ s}^{-1} \\ A(t=20 \text{ min}) &= \lambda N_0 e^{-\lambda t_{\text{dim}}} = 128,5 \cdot 10^3 \text{ kBq} \\ \frac{A(t=20 \text{ min})}{A(t=45 \text{ min})} &= 0,1556 \sim 15 \% \end{aligned}$$